# Assessing Multiple Functions of Missouri's Bottomlands:

## Laying the Groundwork For Wetland Conservation

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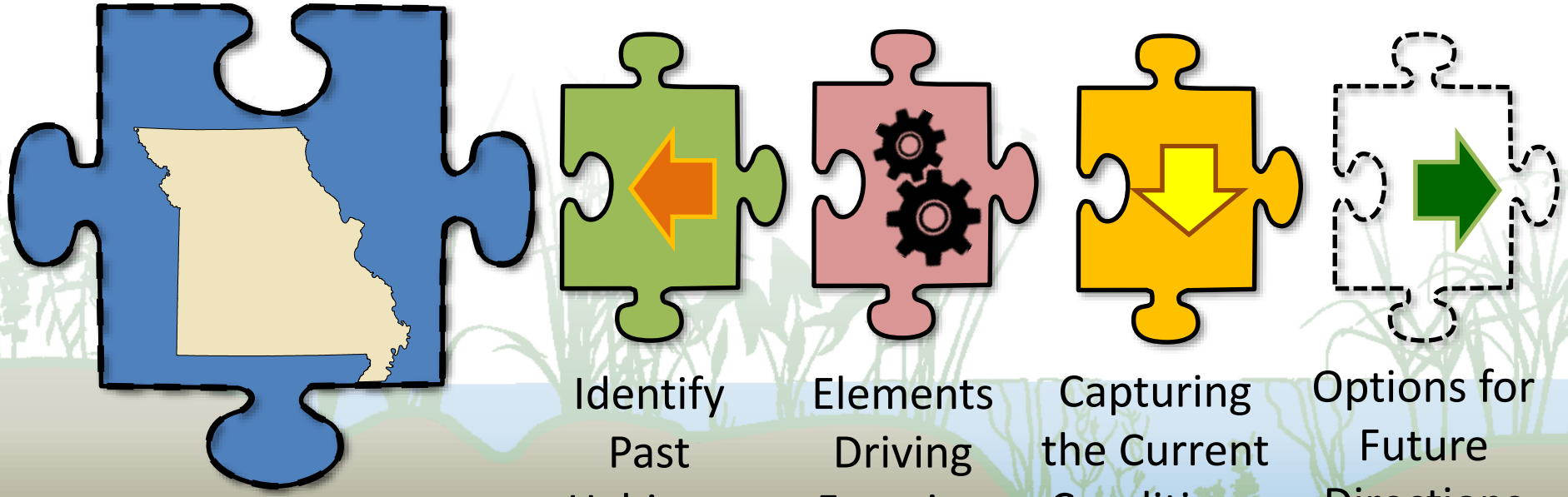
Doreen Mengel (MDC), Andy Raedeke (MDC),

# Project currently in progress

- Collaboration by:
  - EPA, MDC, and MO Resource Assessment Partnership
- Projected to finish by Sept. 2018
- Presenting Preliminary Results
  - Outline context of Missouri's wetland landscape

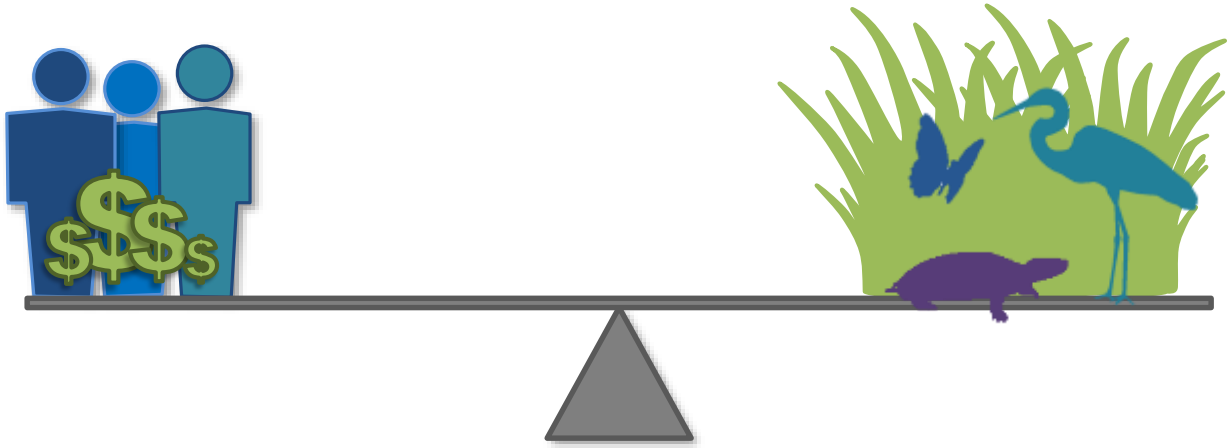


# A Common Mission of Balance

## Association of State Floodplain Manager's

Mission: Balance current and future flooding impacts

- Human suffering, losses, and costs
- Protect the natural and beneficial functions of floodplains
  - *without causing adverse impacts*

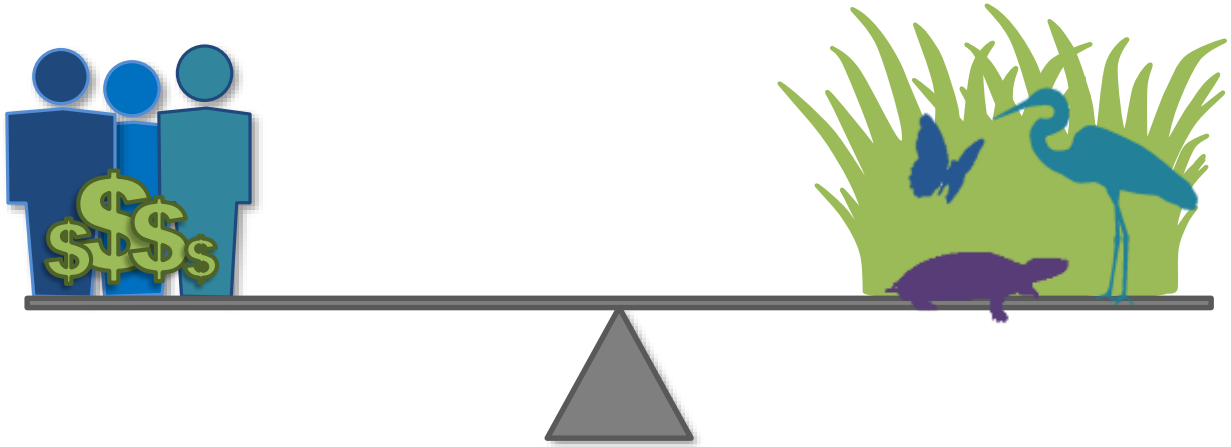



Association of State Floodplain Managers

# A Common Mission of Balance

**Missouri Department of Conservation's** Wetland Conservation Mission:

- To protect, restore, and enhance wetland ecological functions and values for multiple social and natural resource benefits
  - *Also implies a balancing act*

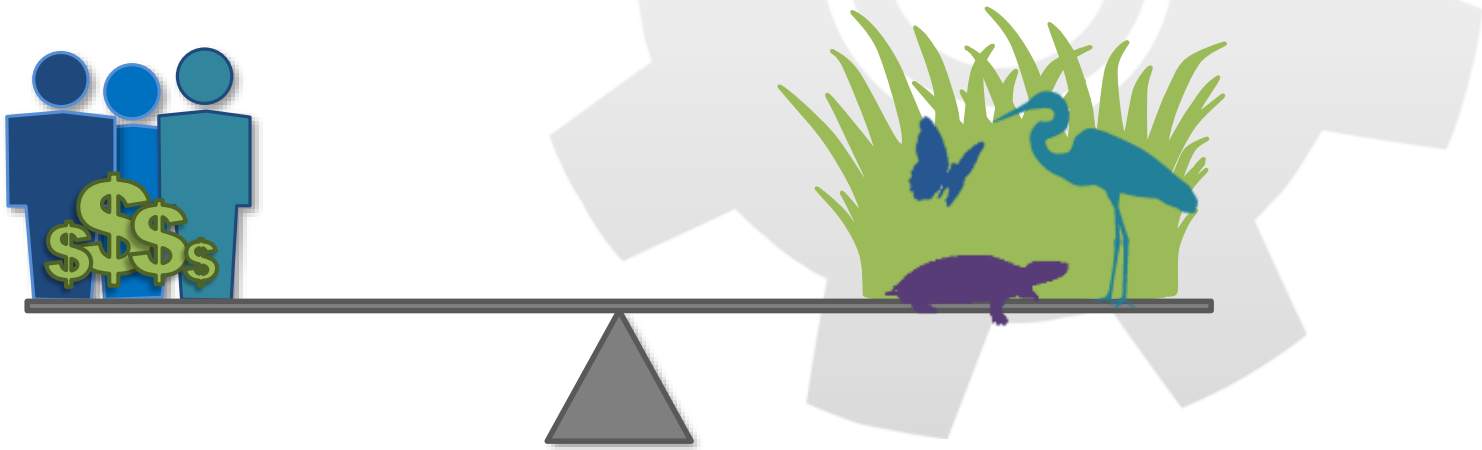


# We all tend to have our biases

Depending upon expertise and livelihood

- May focus on the economics
- May focus on a specific critter or recreational use

- Rarely do we appreciate the services running in the background that sustain the economics, species, and recreational opportunities.

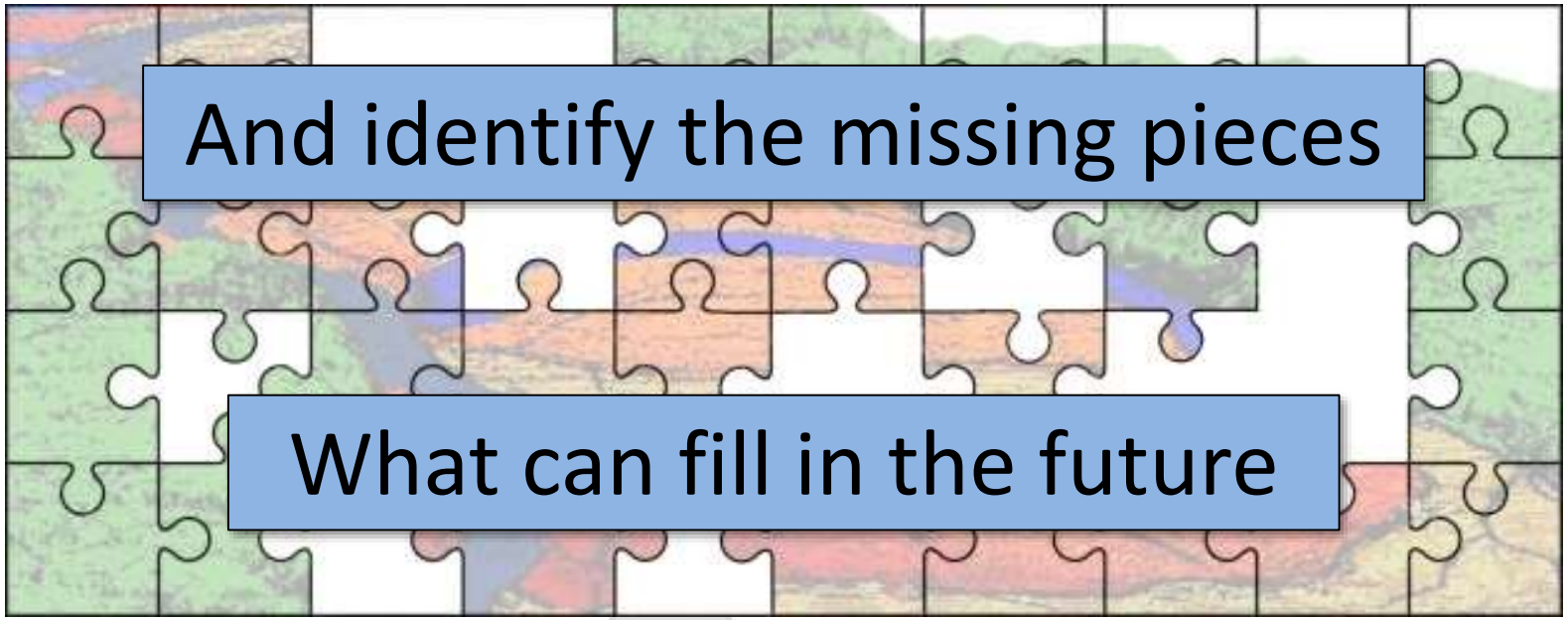


# Balancing Act

**To achieve our collective missions**:

- Need to identify the various pieces of the puzzle, both past and present

- Figure out how they go together



# Missouri Wetlands

## Missing Pieces

- Lack comprehensive layer of:
  - Historic floodplain habitats
    - How much wetlands did Missouri have?
- Best source is 1990 report by Dahl, "Wetland losses in the US 1780's to 1980's"


# Missouri Wetlands

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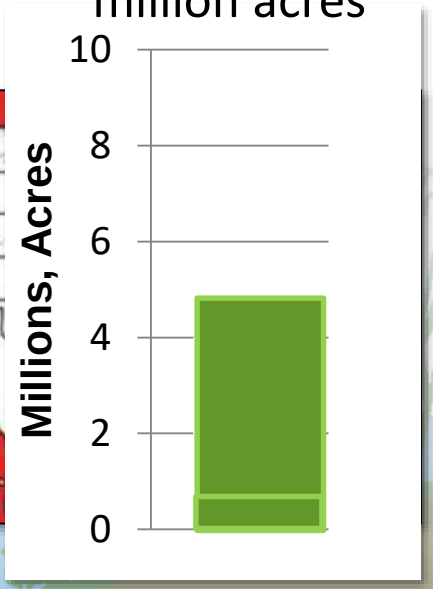
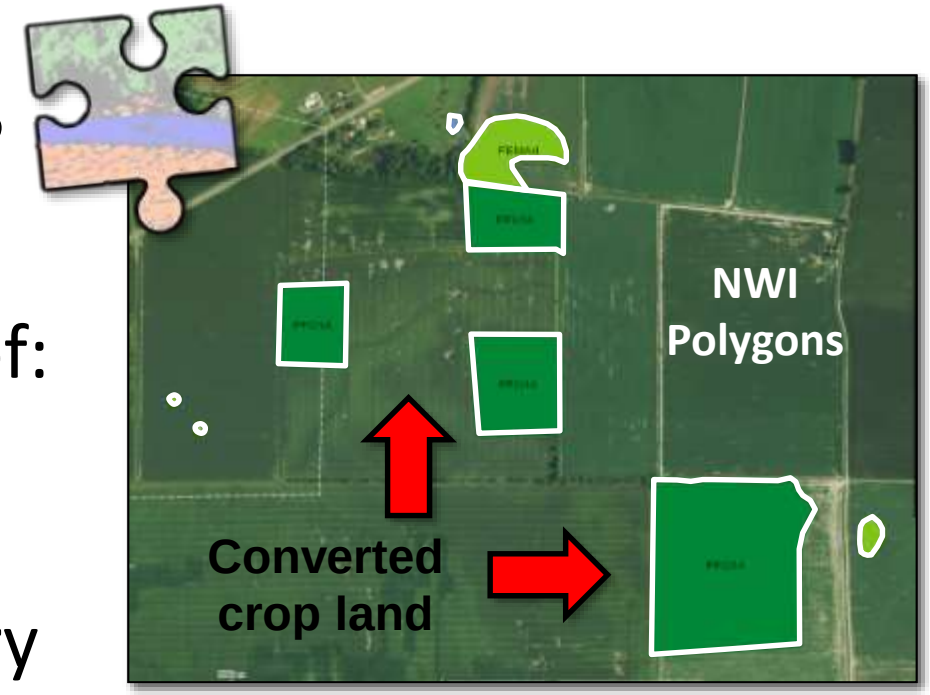



But only **643,000** acres in 1990

# Missouri Wetlands

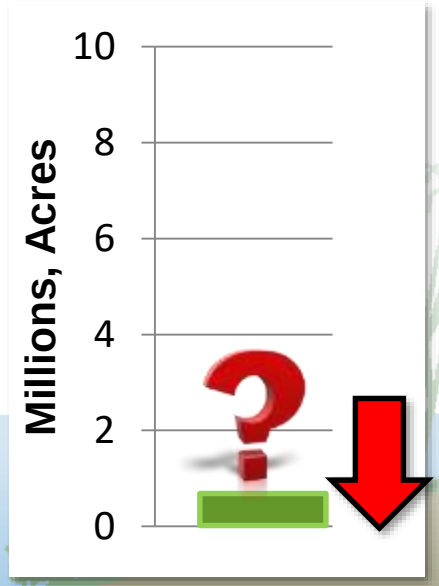



*Another* Missing Piece

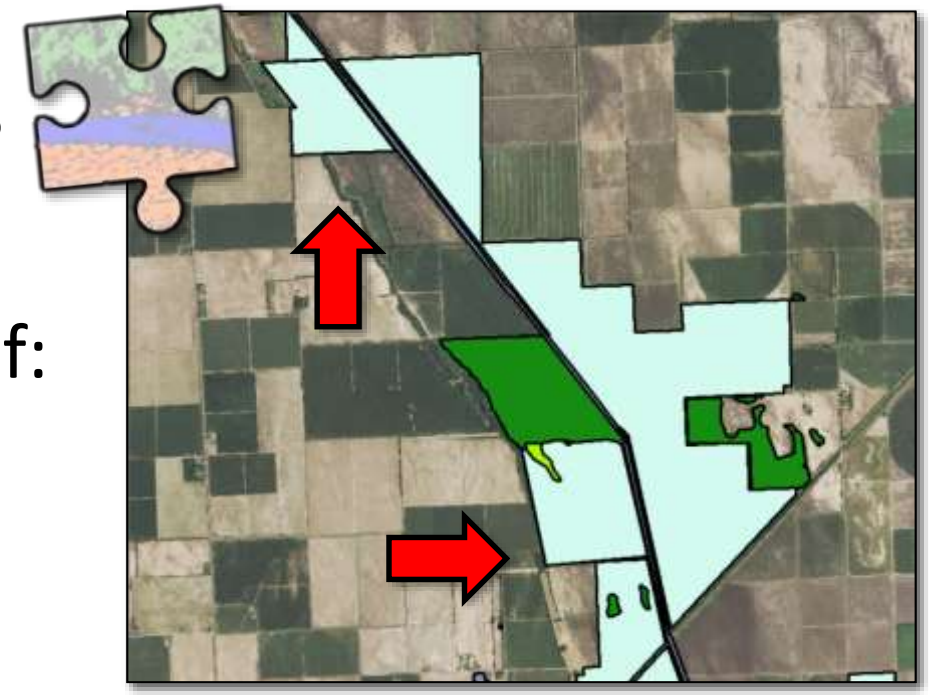
- Lack comprehensive layer of:
  - *Current* floodplain habitats

- National Wetlands Inventory (NWI) is outdated and additional wetland acres have been converted to crop land

- How much???




# Missouri Wetlands



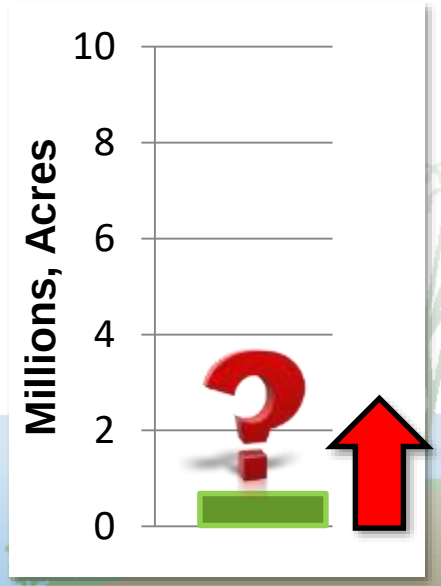
Restored wetland in WRE

*Another* Missing Piece

- Lack comprehensive layer of:
  - *Current* floodplain habitats

- Wetland Reserve Easement (WRE) Program has added ~150,000 acres to Missouri's floodplains

- So how much overall???



# How do the pieces fit together?

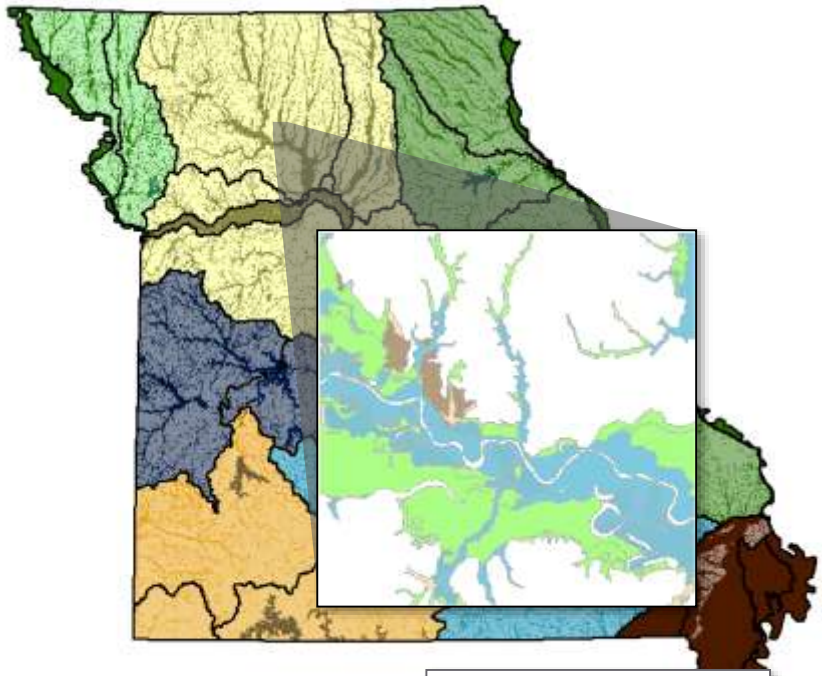
- Not just about numbers?
- What was the contribution?
- What role do they play today?

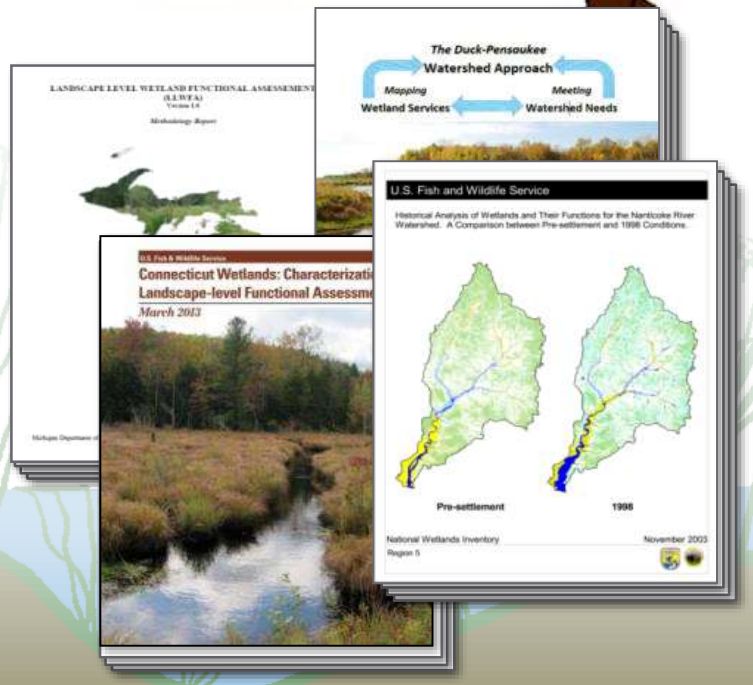






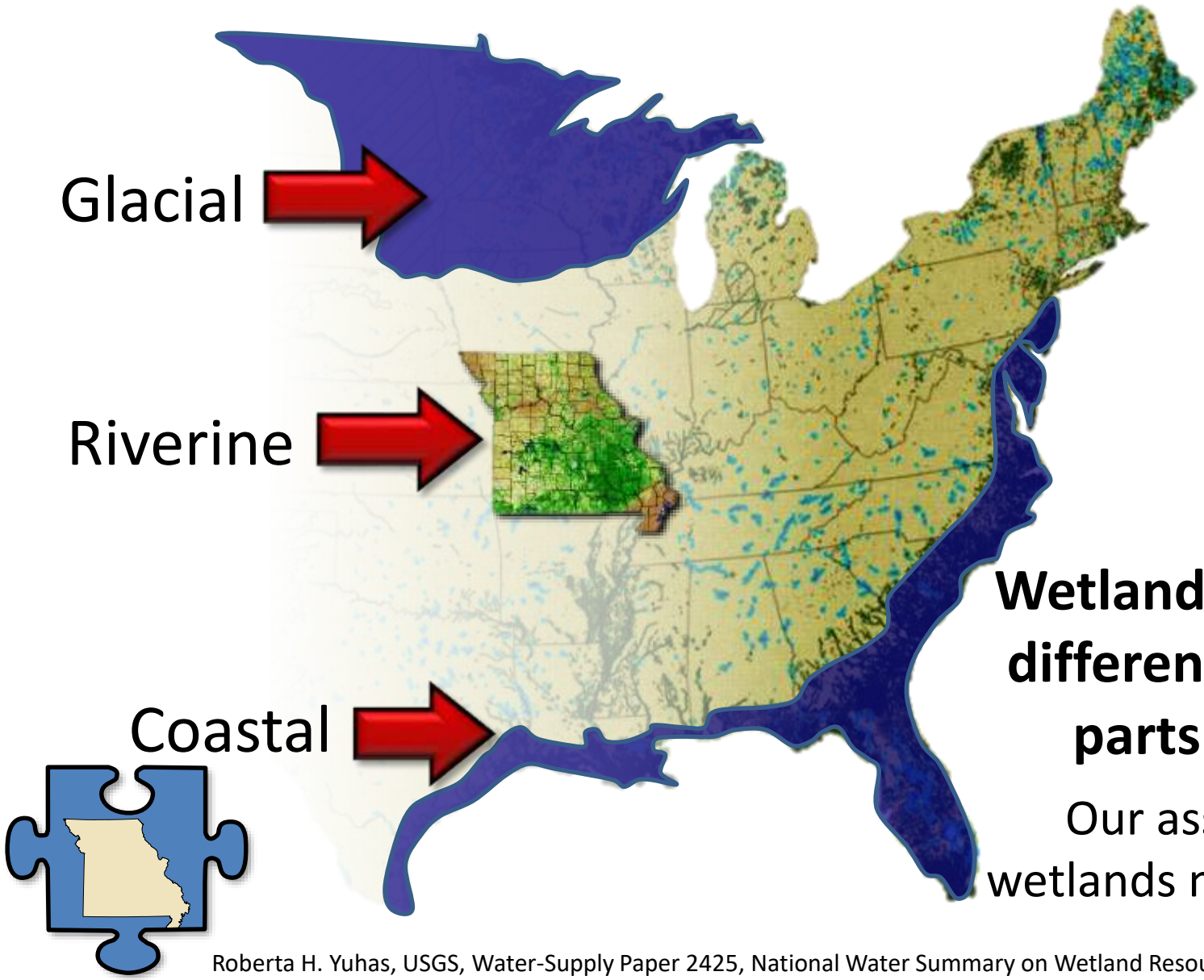
# Consensus on Need






- Multiple agencies agreed Missouri needed better:
  - Historical Wetland Baseline
  - Current Wetland Extent
  - Tie to Ecological Functions/Services
- Several examples on how to accomplish this from other states and watersheds

# Considering Missouri's Unique Landscape

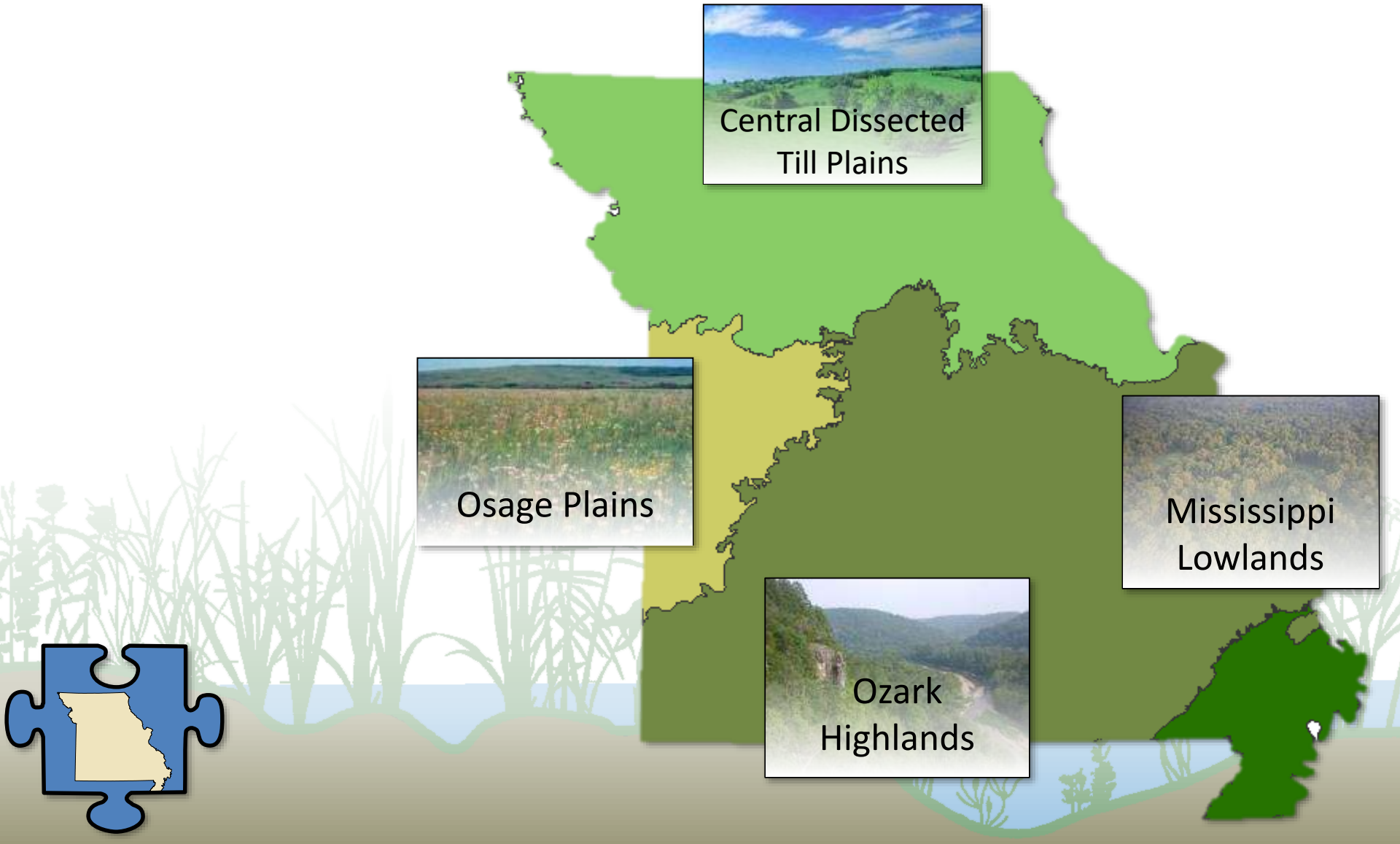



**Wetland formation is different from other parts of the US**

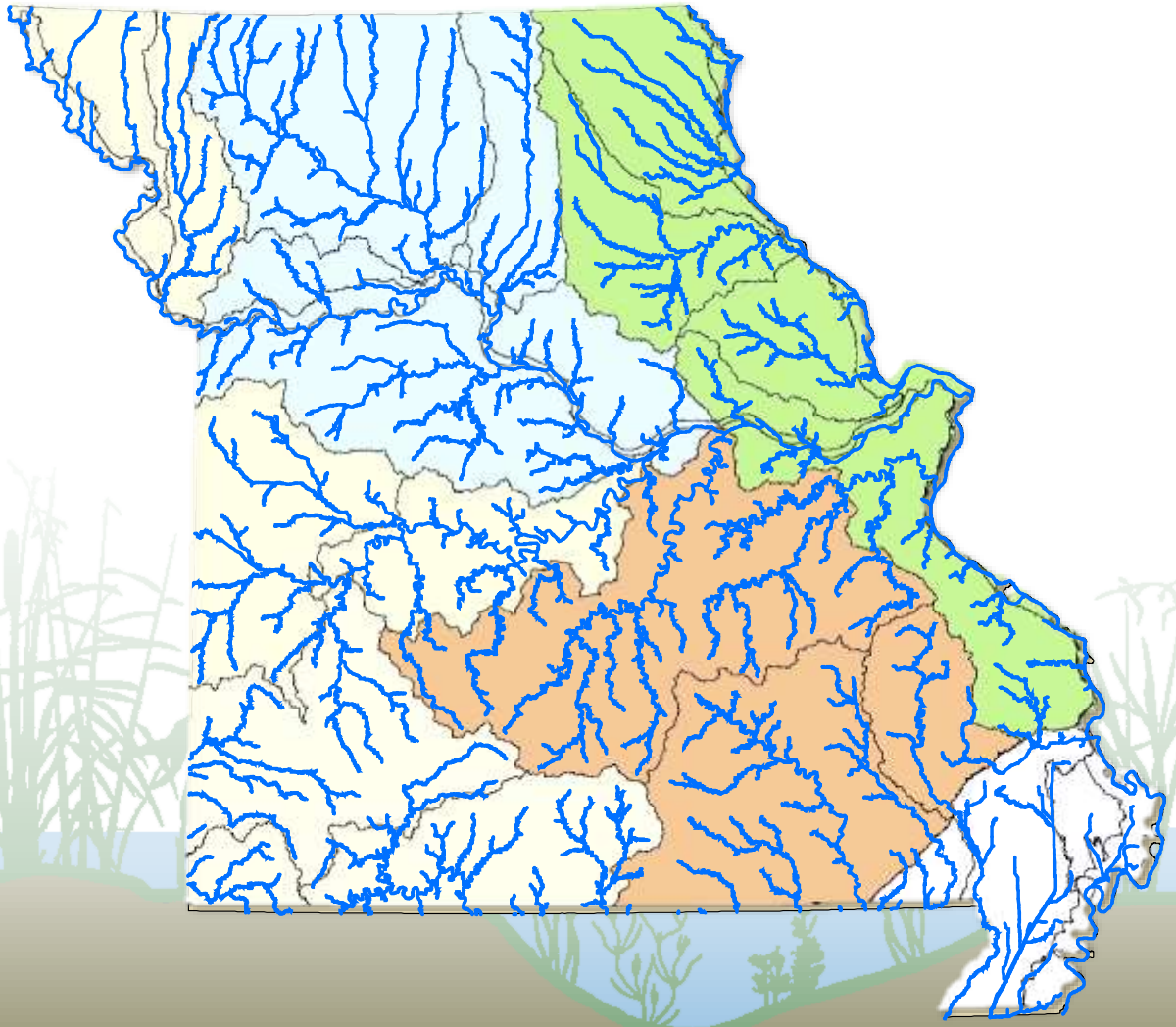
Our assessment of wetlands may be tweaked

Roberta H. Yuhas, USGS, Water-Supply Paper 2425, National Water Summary on Wetland Resources, 1996

# Considering MO's Regional Variation in Terrestrial Communities



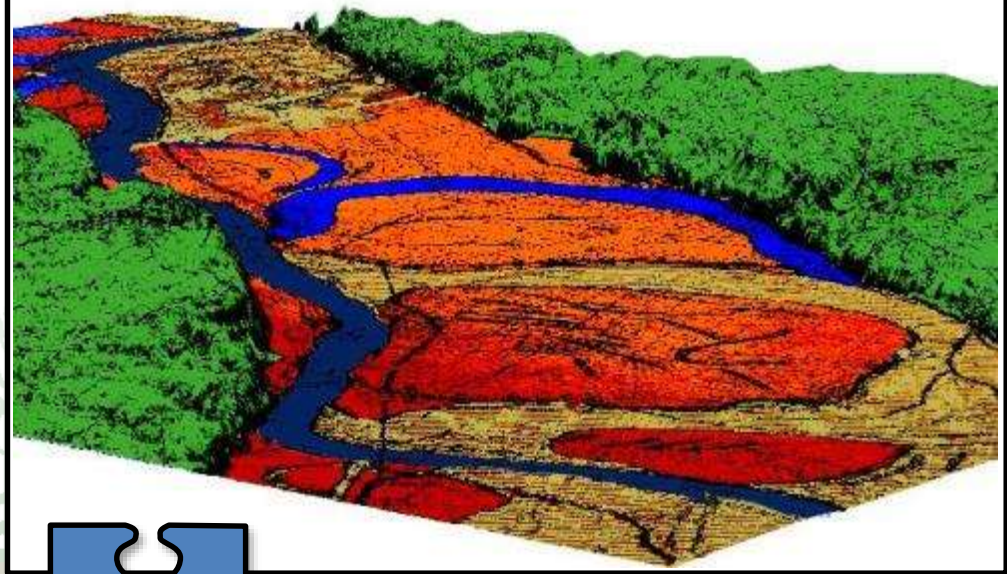
# Considering MO's Regional Variation in Aquatic Communities

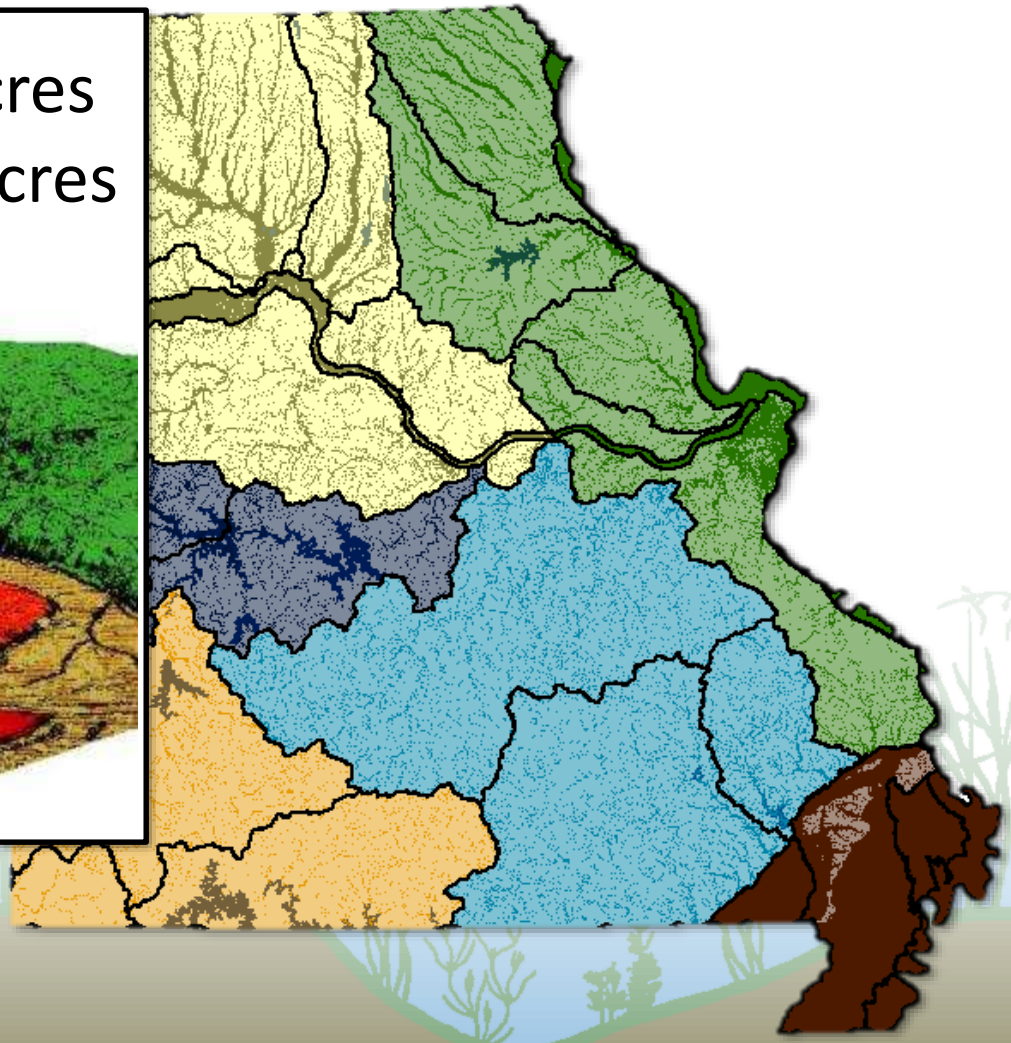


# Created Ecological Wetland Regions

## Hybrid of Terrestrial/Aquatic Systems

9.6 million bottomland acres
=22% of MO's 44 million acres

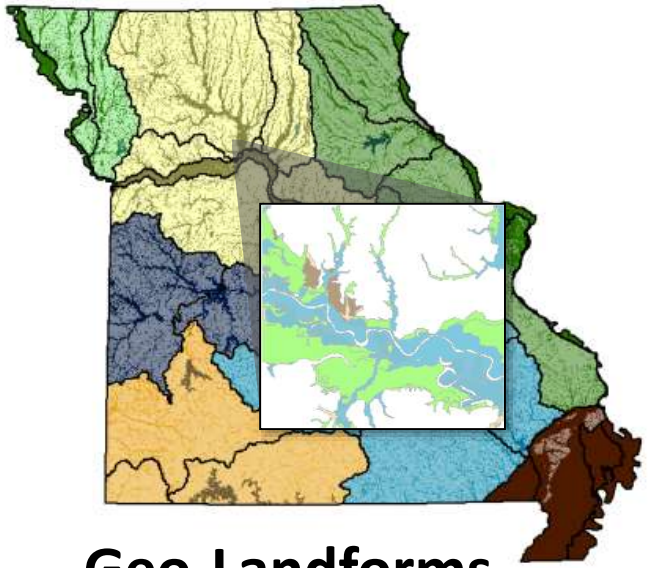




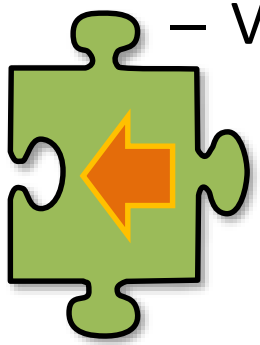
# Establishing the historic baseline

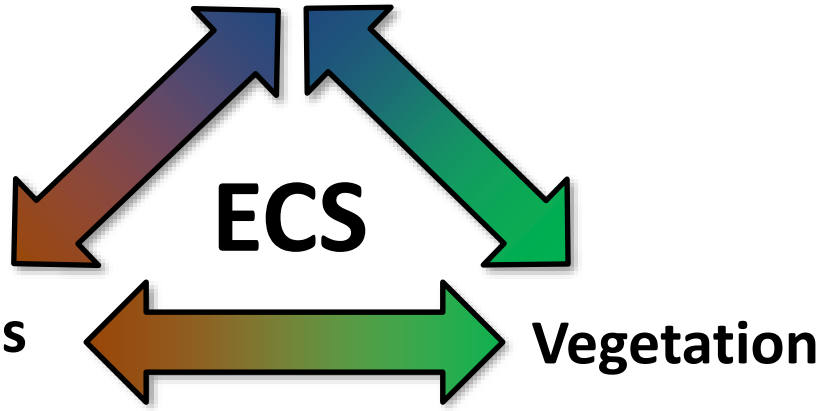
## Missouri Ecological Classification System (ECS)

- **MDC and NRCS Developed**
- **Geospatial Dataset**
  - Spatial extent 1-100s acres
  - Soil map unit scale (>5 acres)
- **Defines Communities Based**
  - Geo-Landforms
  - Soil Properties
  - Vegetation



**Geo-Landforms**

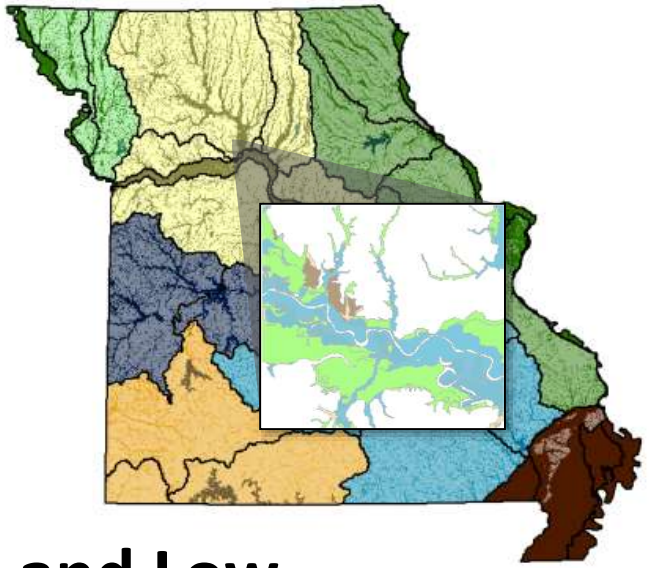




# Establishing the historic baseline

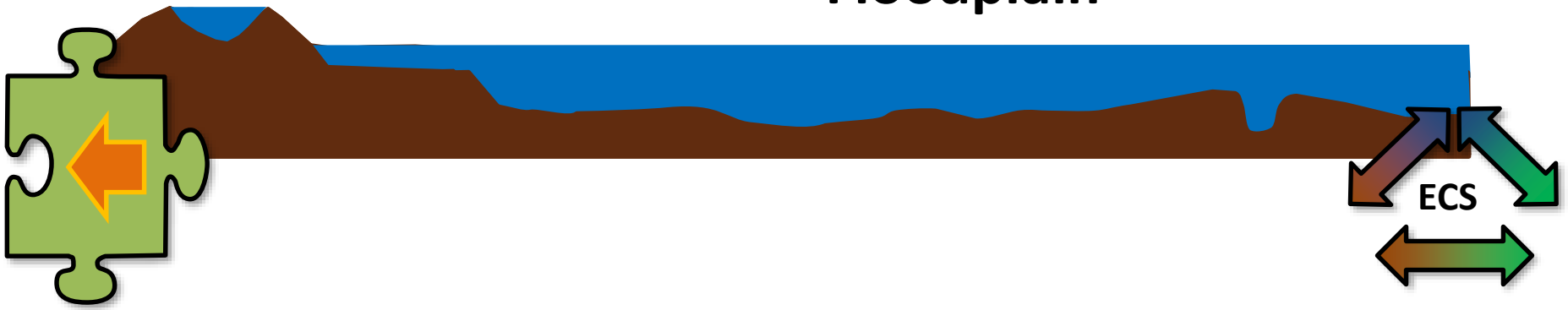
## Missouri Ecological Classification System (ECS)

- Works out well for describing MO bottomland habitats
- Consider Geo-landforms



**Upland**

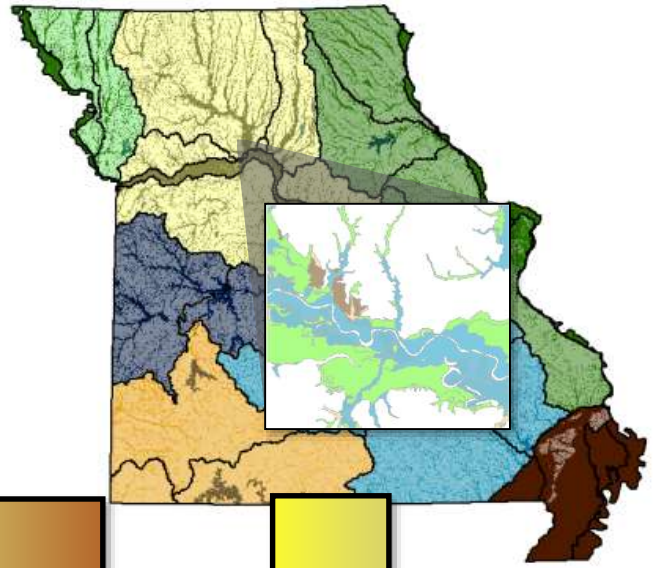
**Drainageways** **Terraces** **High and Low Floodplain**

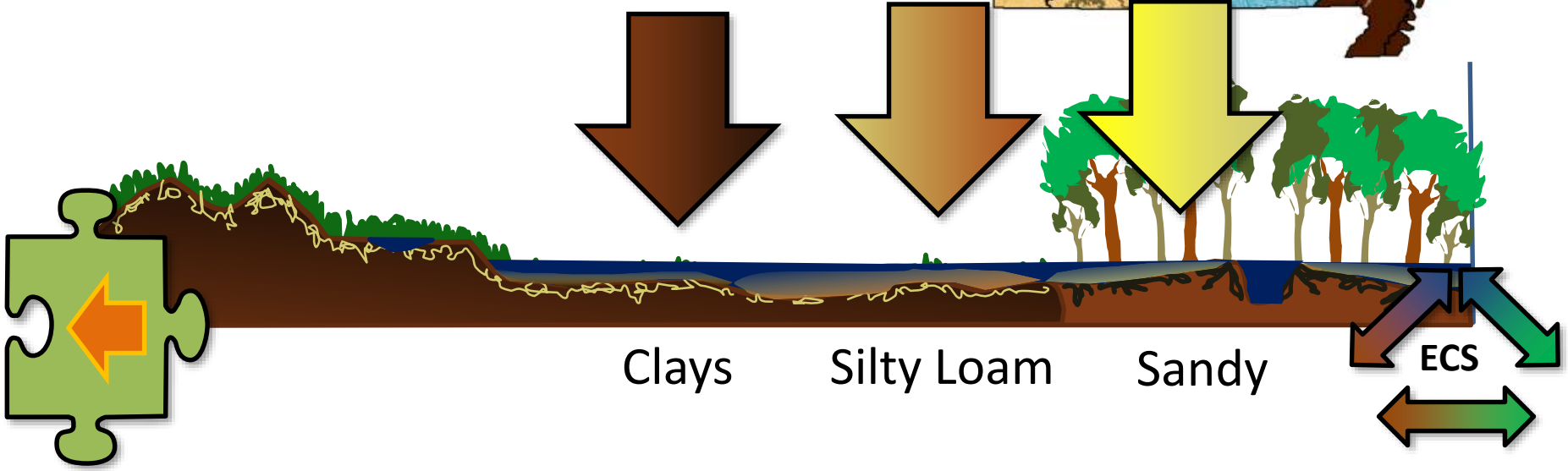


# Establishing the historic baseline

## Missouri Ecological Classification System (ECS)

- Works out well for describing MO bottomland habitats
- Consider Soils



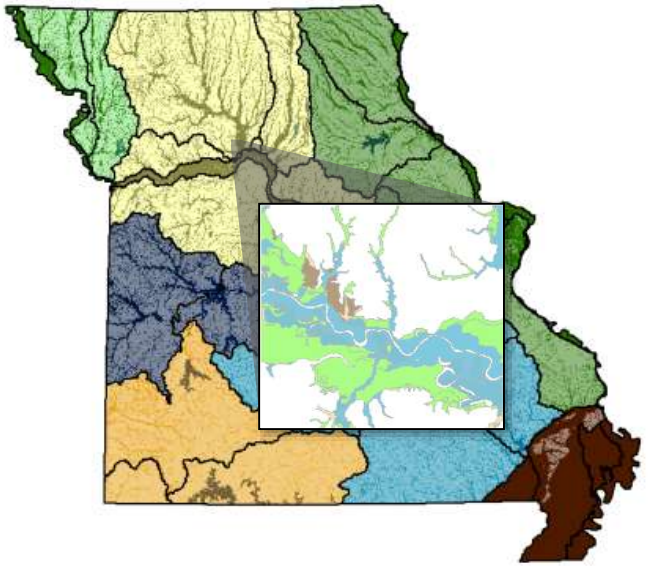


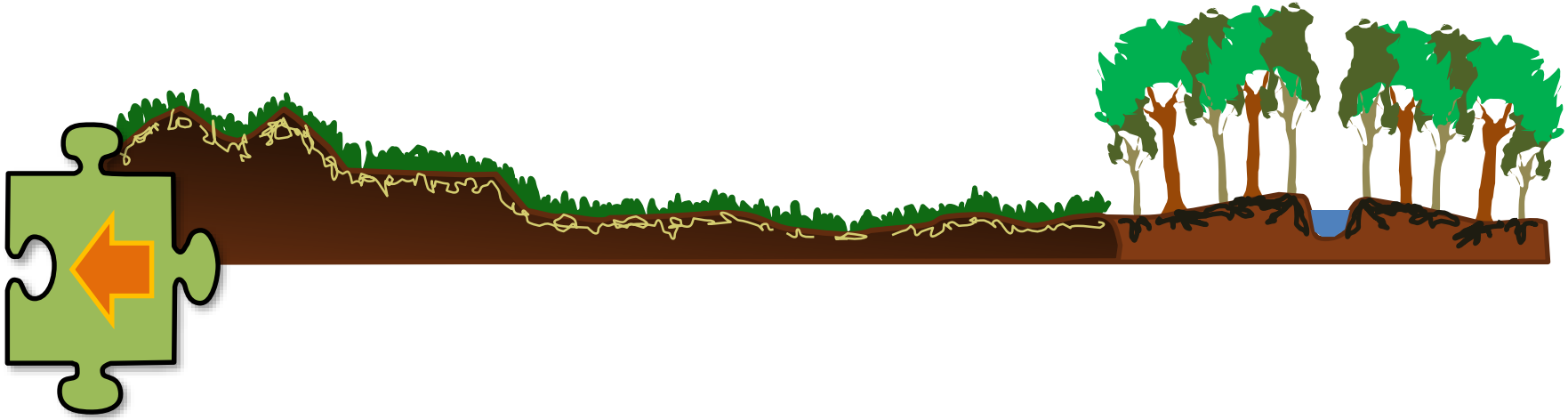
# Establishing the historic baseline

## Missouri Ecological Classification System (ECS)

- Works out well for describing MO bottomland habitats

- Consider Soils and Vegetation





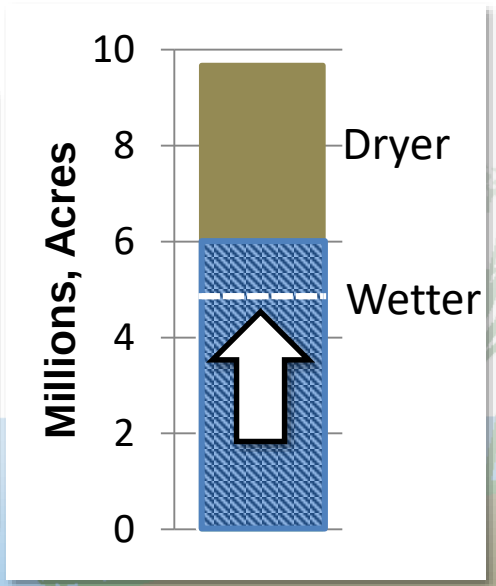
# Establishing the historic baseline

## Missouri Ecological Classification System

- Including bottomland habitats ~9.5 million acres

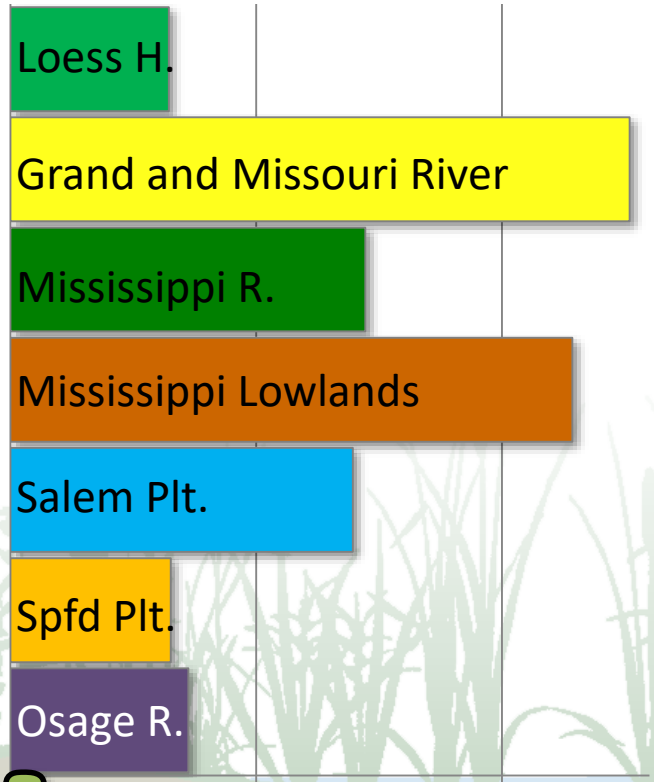
- Look at the wetter habitats→ new historic wetland est.

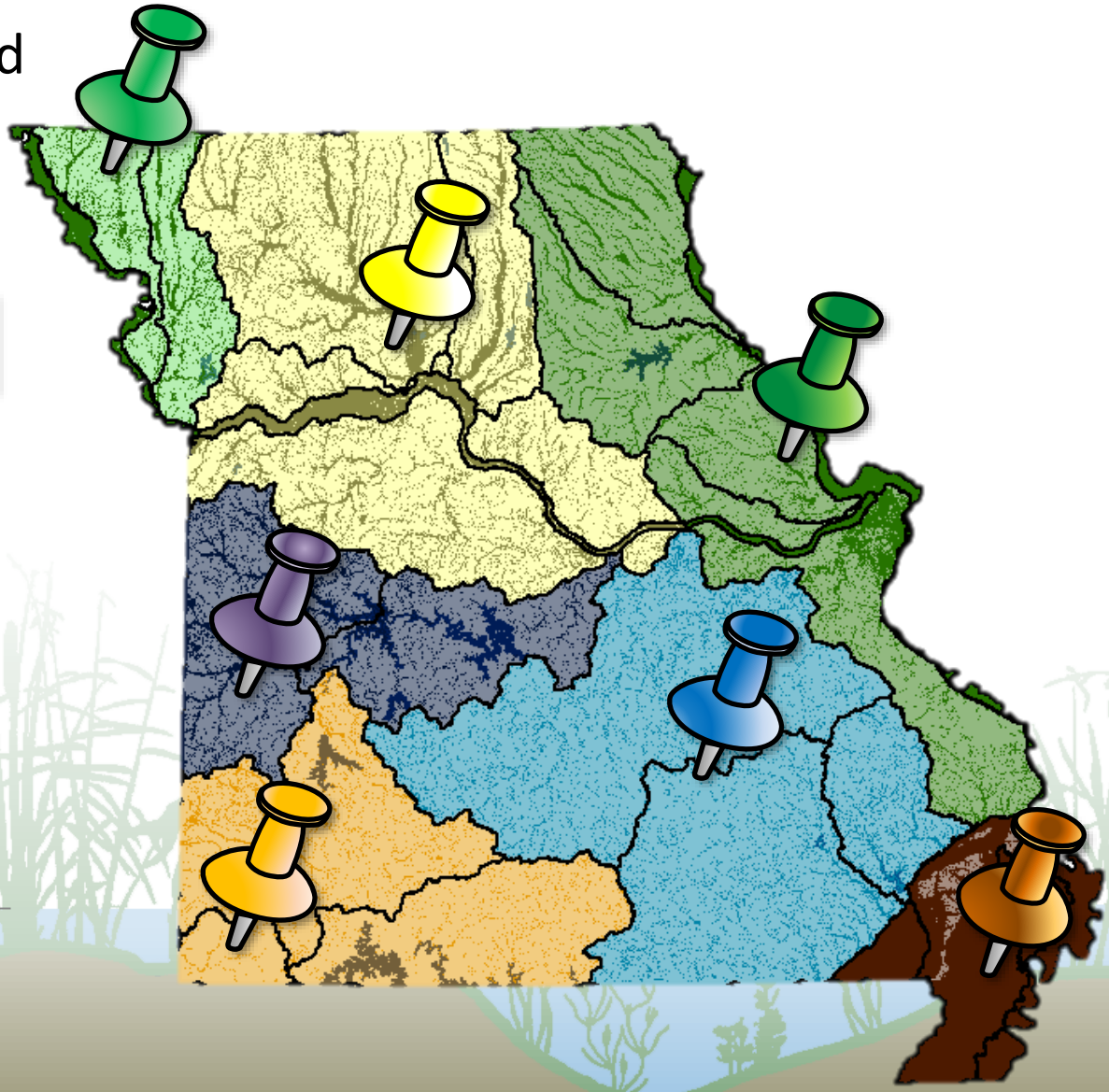
  = 6 million acres, an increased amount from Dahl 1990



# Establishing the historic baseline

Distribution of Bottomland Acres by Region

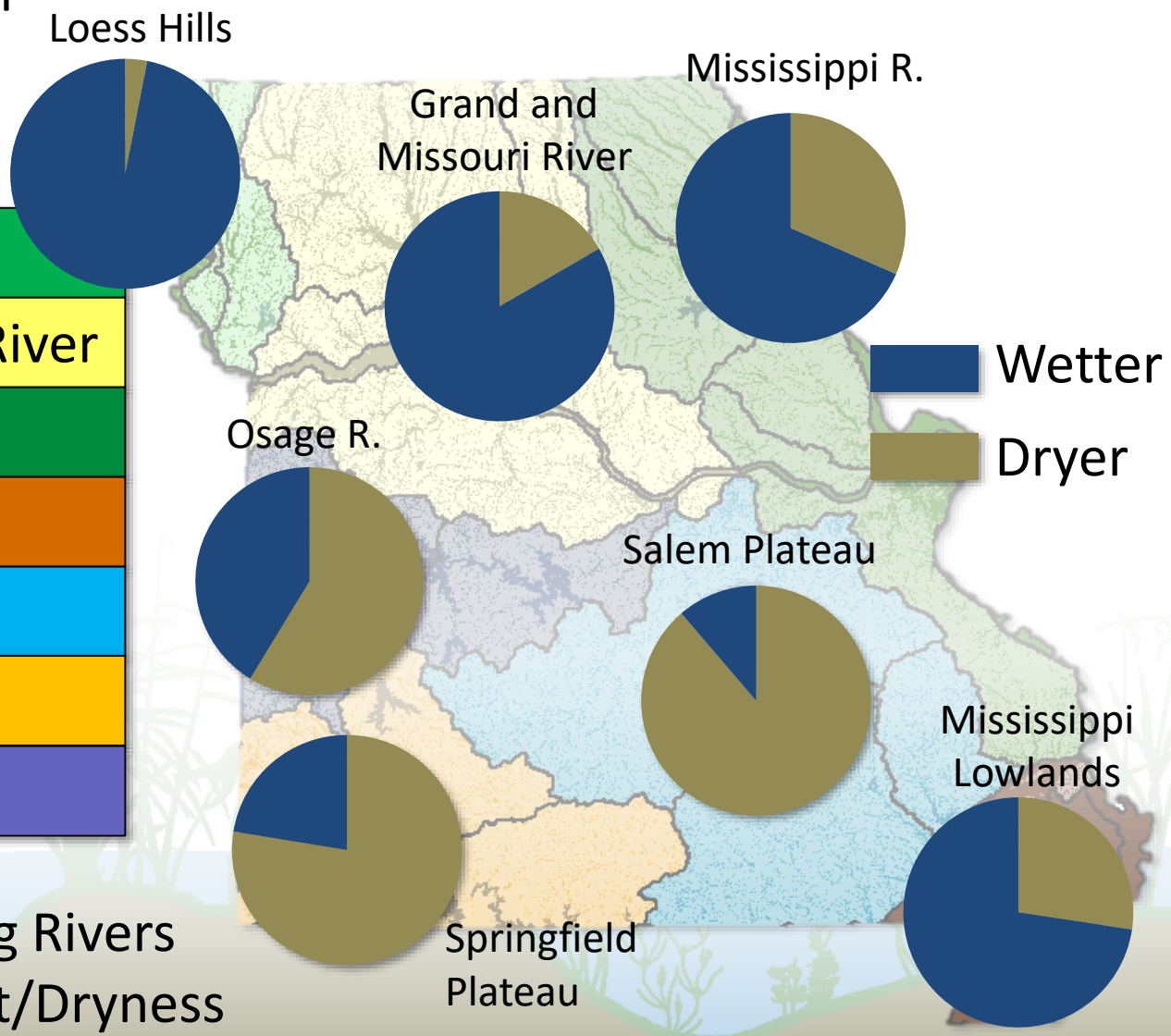


# Establishing the historic baseline

Percent Wetter/Dryer Bottomland within Region

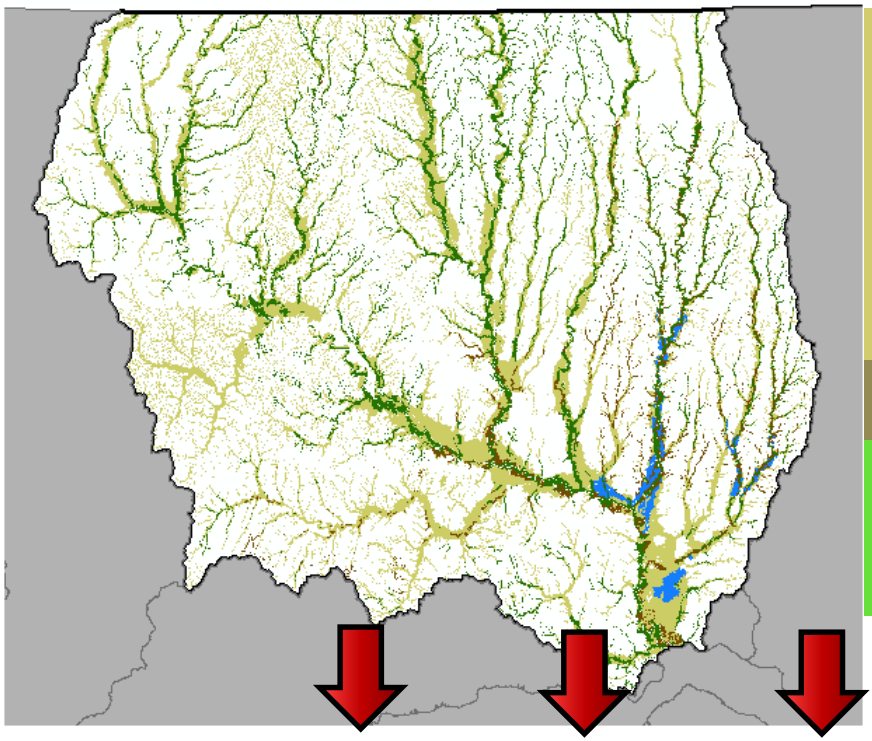
- Loess Hills
- Grand and Missouri River
- Mississippi River
- Mississippi Lowlands
- Salem Plateau
- Springfield Plateau
- Osage River




Geology and Big Rivers Influence the Wet/Dryness

# Good Regional Summaries of Historic Habitats

## Sub Region: Grand River Hills



Common Ecological Site Descriptions

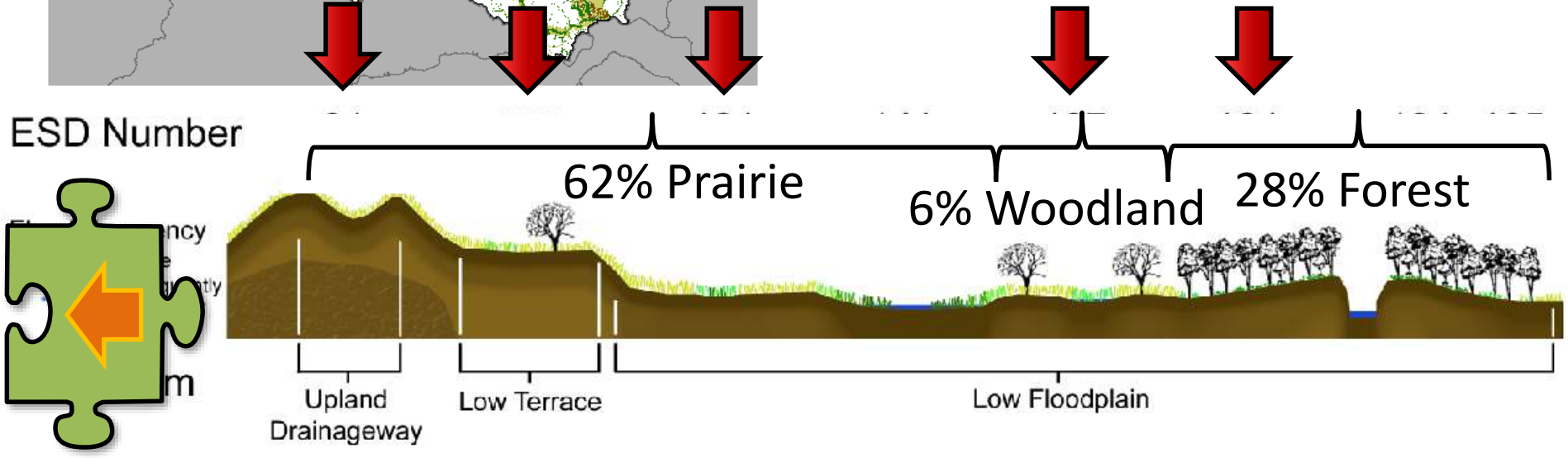
**Prairie**

- Mollic Wet Upland Drainageway Prairie and Savanna
- Mollic Wet Terrace Prairie & Savanna
- Wet Floodplain Prairie

- Wet Floodplain Woodland

**Forest**

- Loamy Floodplain Riverfront Forest

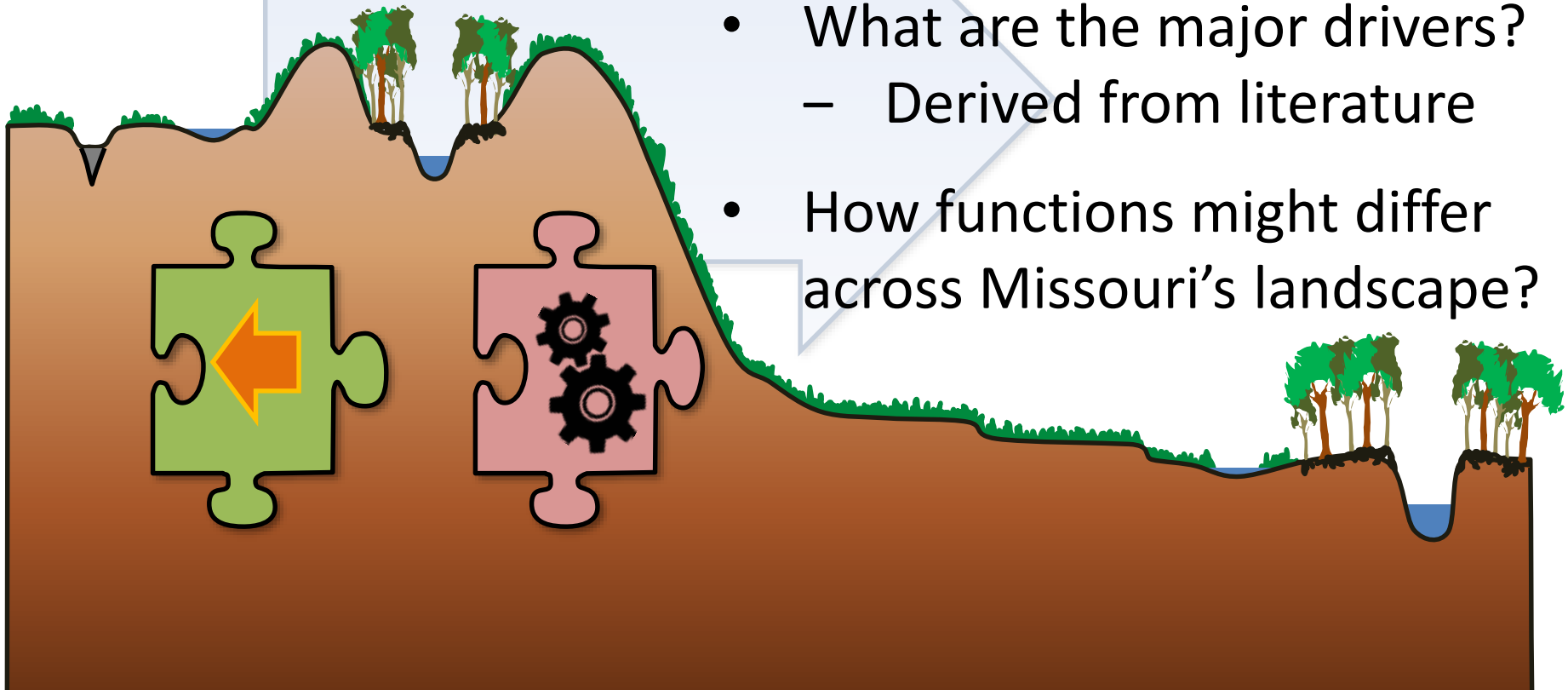


# Next Step:

Linking Historic Communities to Ecosystem Functions

**Needed to Establish**

- What are the major drivers?
  - Derived from literature
- How functions might differ across Missouri's landscape?

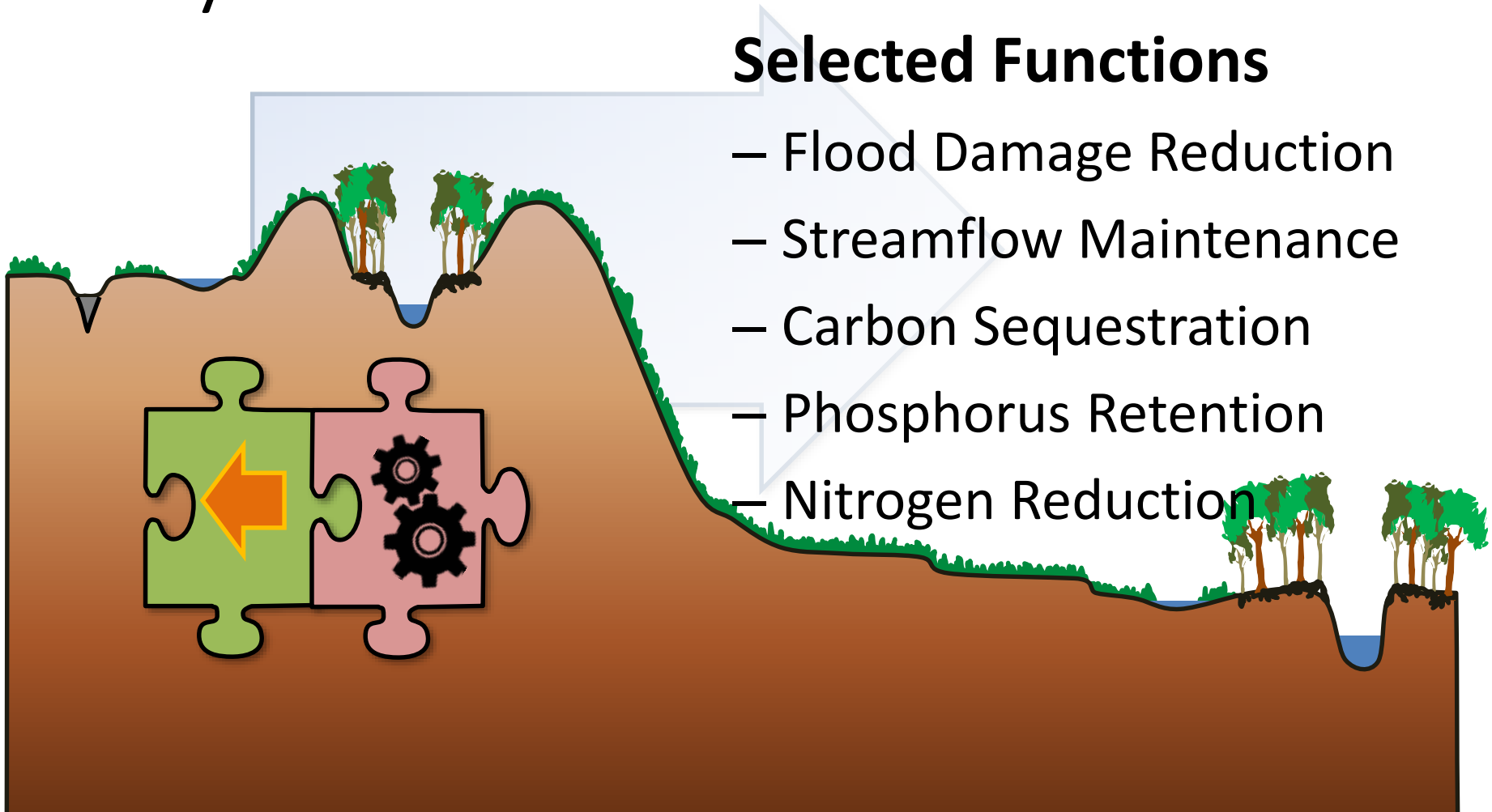


# Next Step:

Linking Historic Communities to Ecosystem Functions

**Selected Functions**

- Flood Damage Reduction
- Streamflow Maintenance
- Carbon Sequestration
- Phosphorus Retention
- Nitrogen Reduction

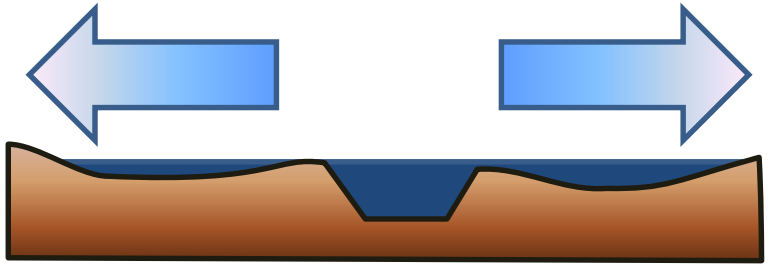


# Missouri Bottomland Functions:

*Flood Damage Reduction*

## Major Drivers

- Adjacent to rivers and streams
  - Lateral Connectivity

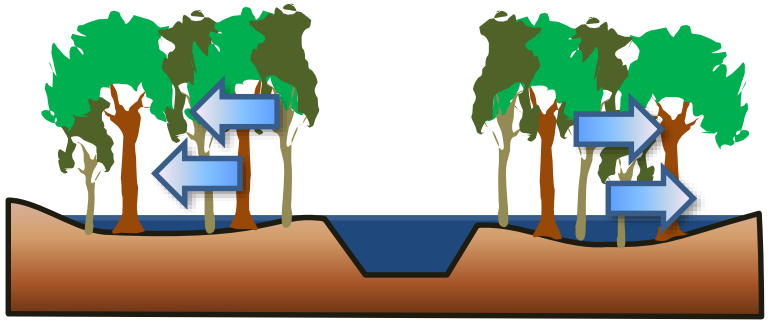


# Missouri Bottomland Functions:

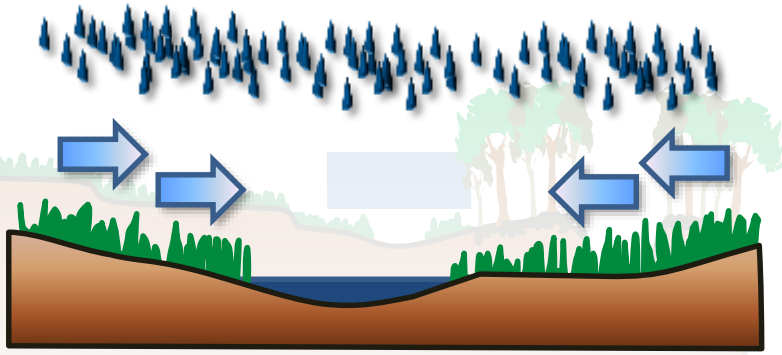
*Flood Damage Reduction*

## Major Drivers

- Adjacent to rivers and streams
  - Lateral Connectivity
  - Slowing flow

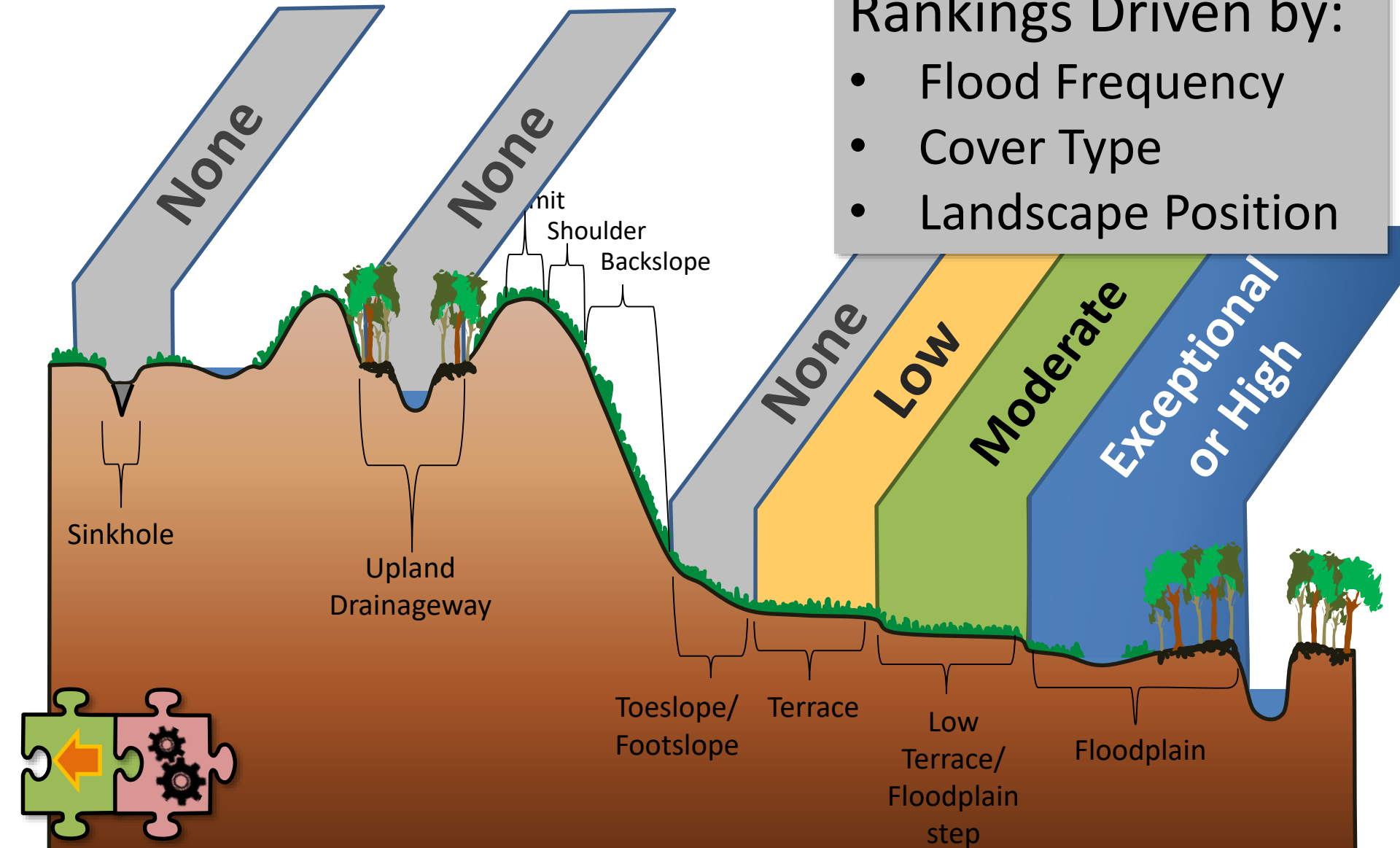


- Not adjacent to rivers and streams
  - Storing water
  - Slowing run-off



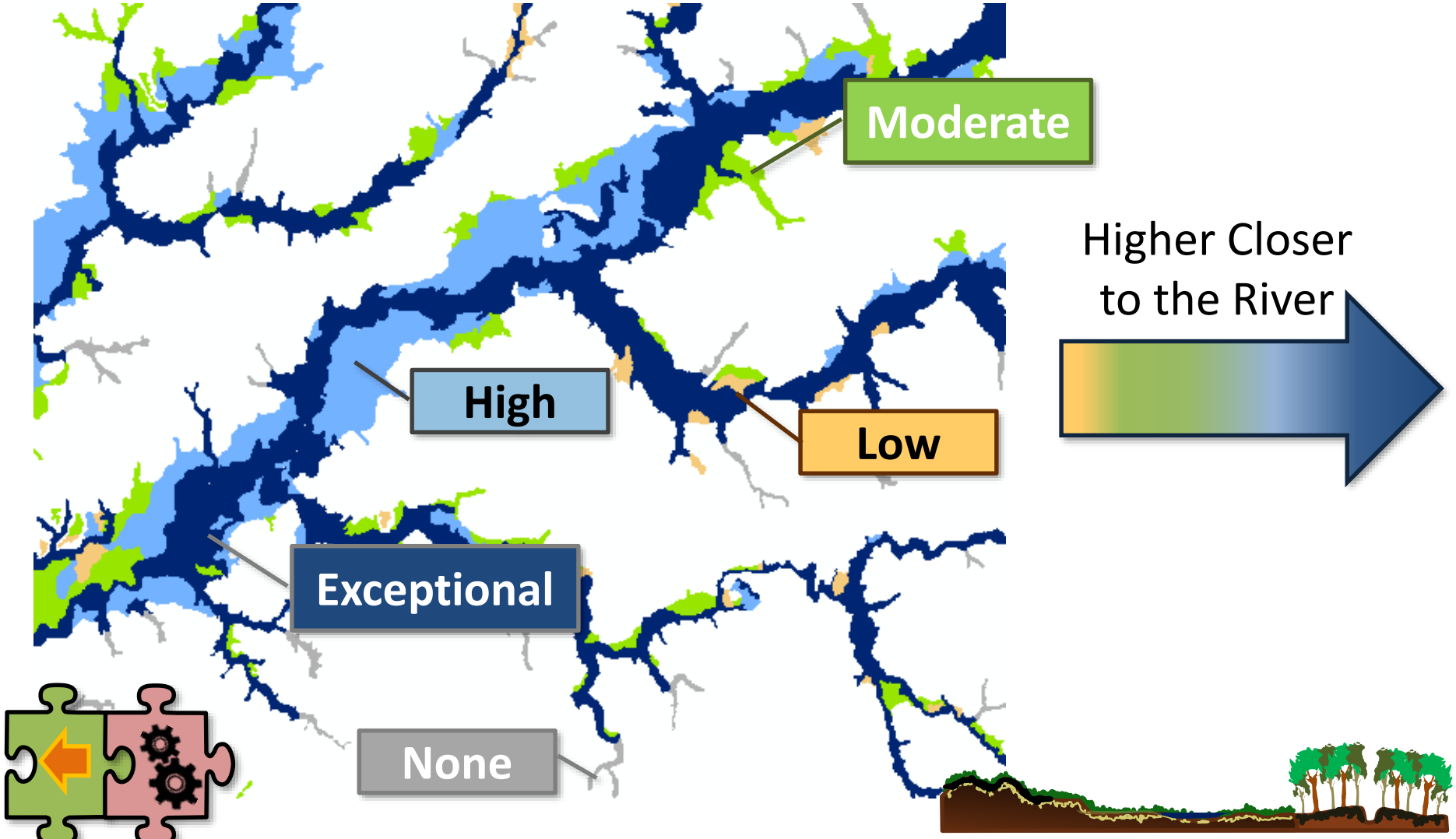
# Missouri Bottomland Functions:

## *Flood Damage Reduction*



# Missouri Bottomland Functions:

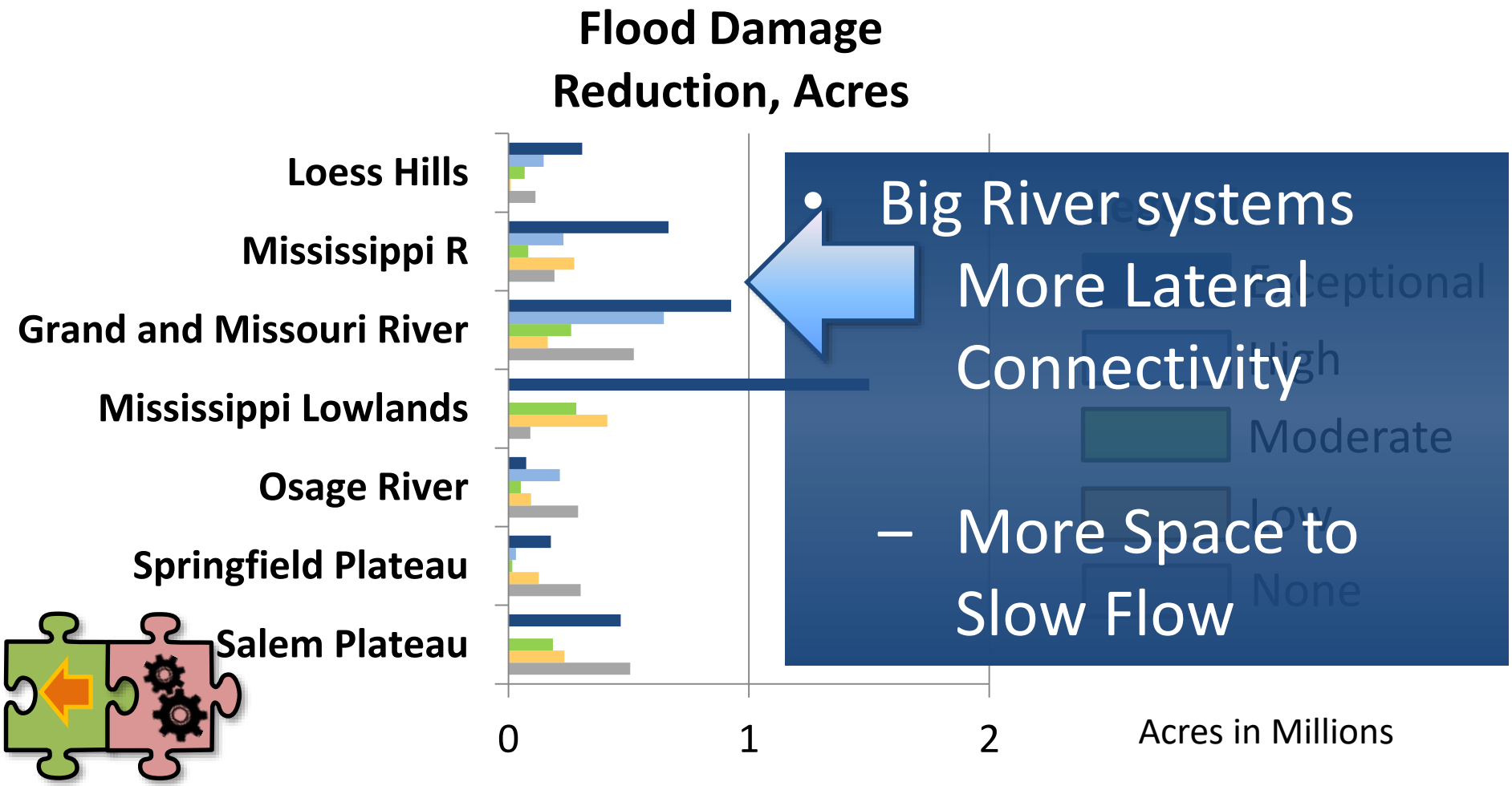
## *Flood Damage Reduction*



# Missouri Bottomland Functions:

*Flood Damage Reduction*

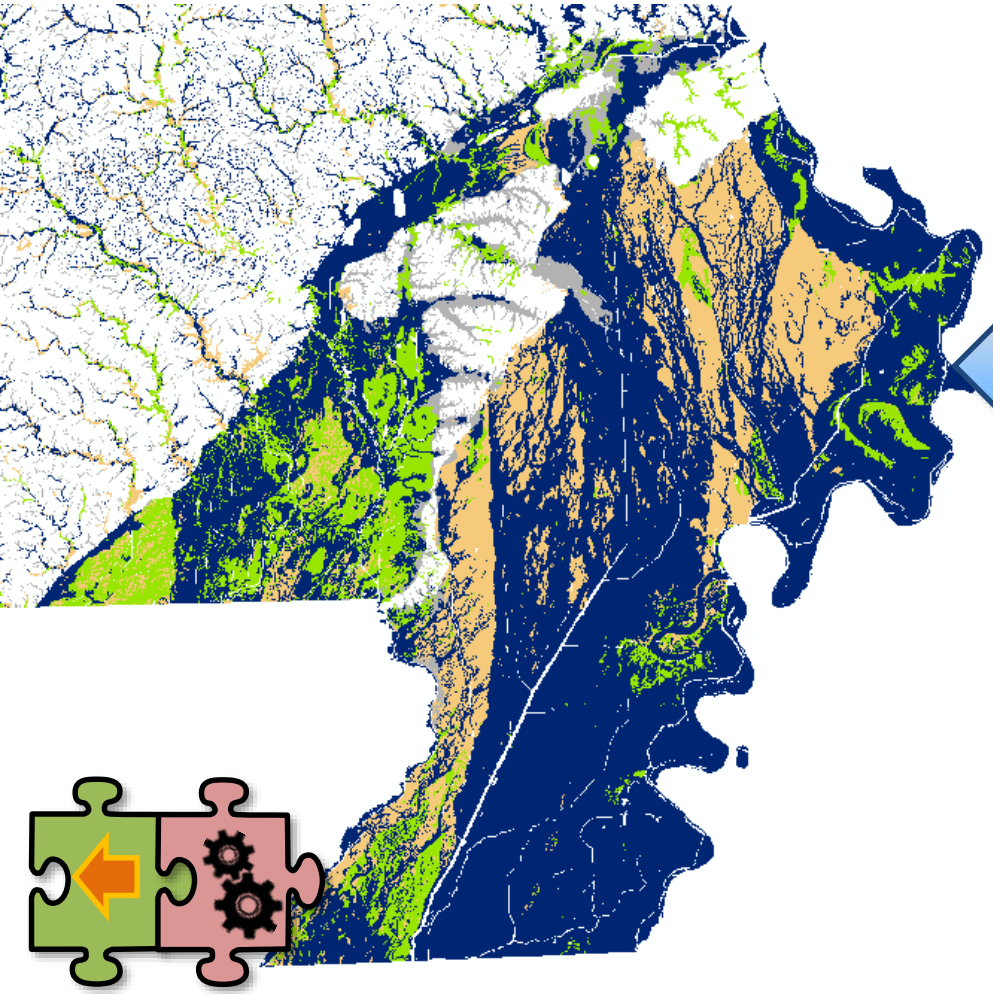
## Preliminary Results for Historic Potential



# Missouri Bottomland Functions:

*Flood Damage Reduction*

## Preliminary Results for Historic Potential



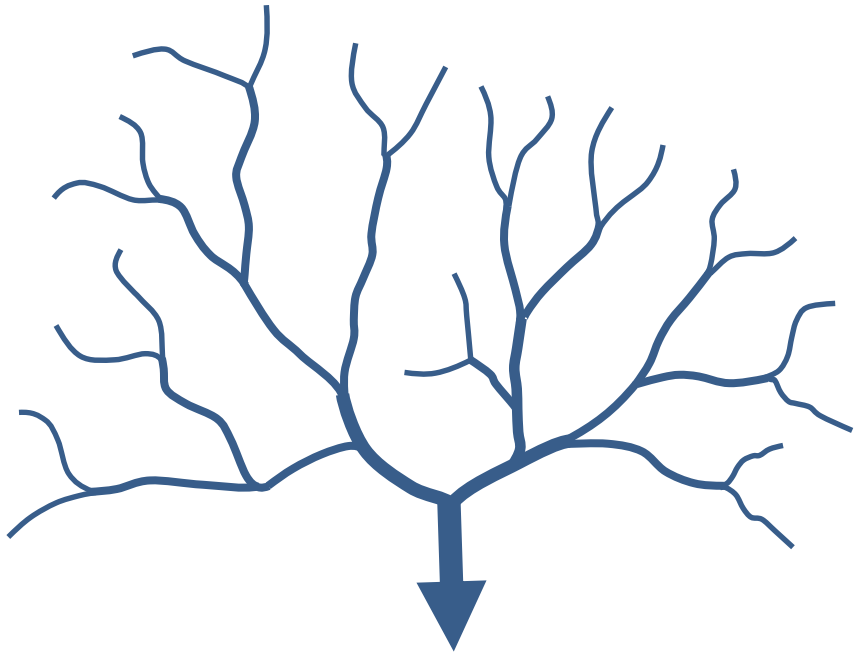
- Big River systems
  - More Lateral Connectivity
  - More Space to Slow Flow

# Missouri Bottomland Functions:

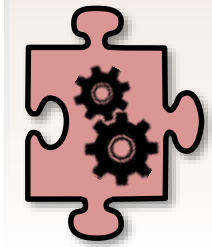
*Streamflow Maintenance*

## Major Drivers

- Headwater locations

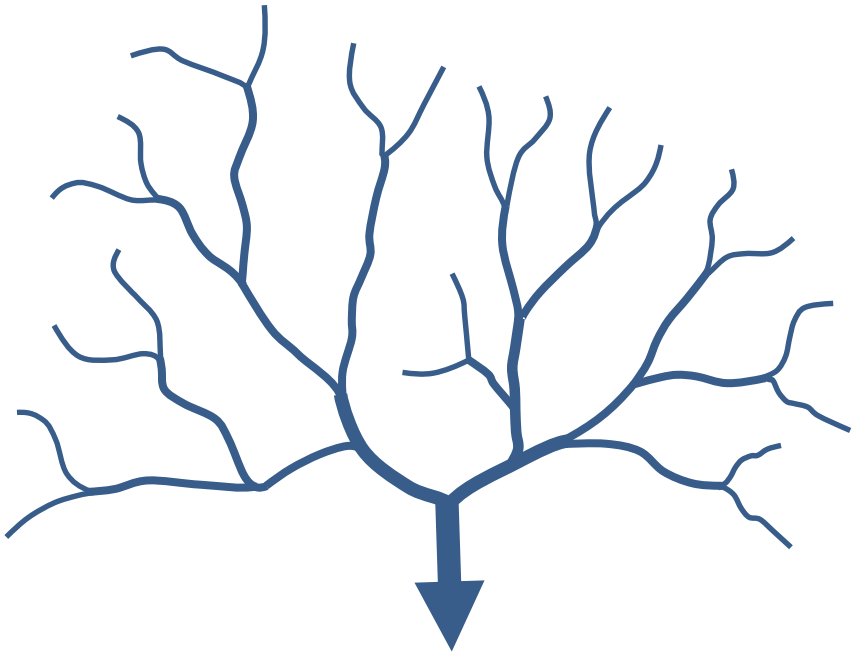


Collective Input of Smaller Streams Add Up



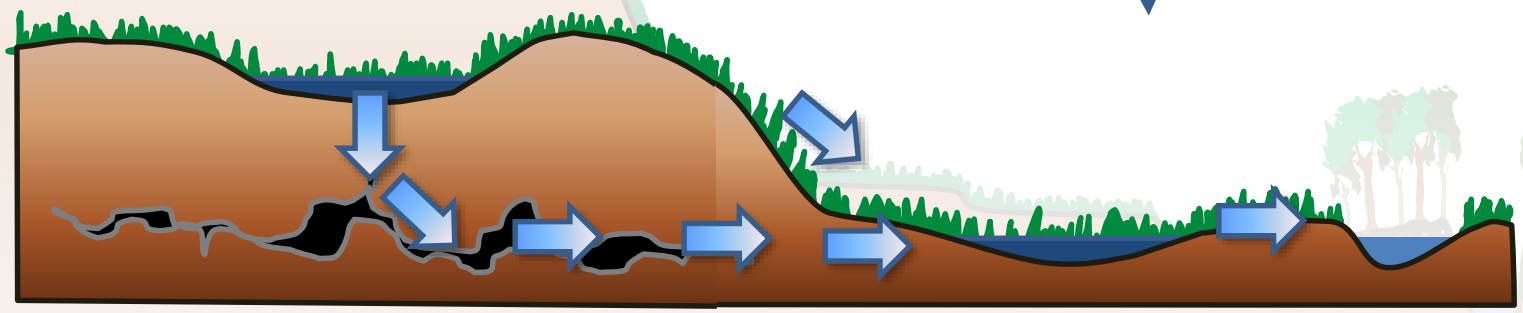
# Missouri Bottomland Functions:

*Streamflow Maintenance*



## Major Drivers

- Headwater locations
- Discharge wetlands
- Connected to aquifer



Sinkholes

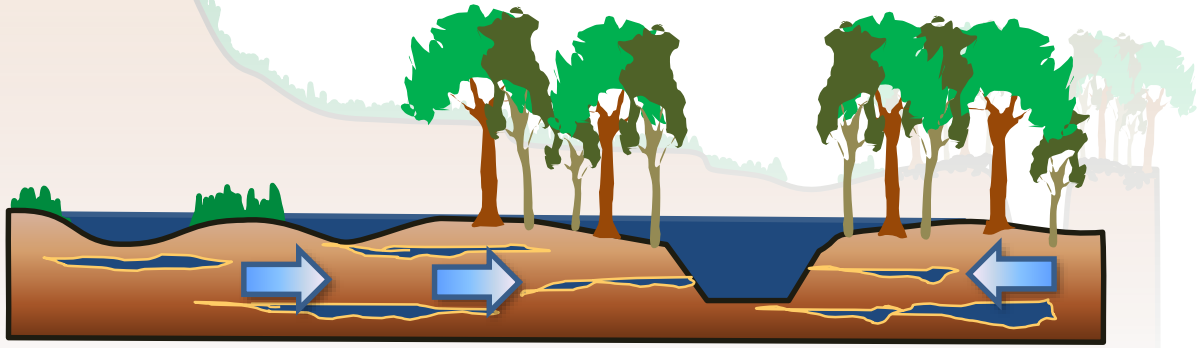
Upland drainageways,
Springs, and footslopes

# Missouri Bottomland Functions:

*Streamflow Maintenance*

## Major Drivers

- Headwater locations
- Discharge wetlands
- Connected to aquifer
- Bank-storage and Infiltration

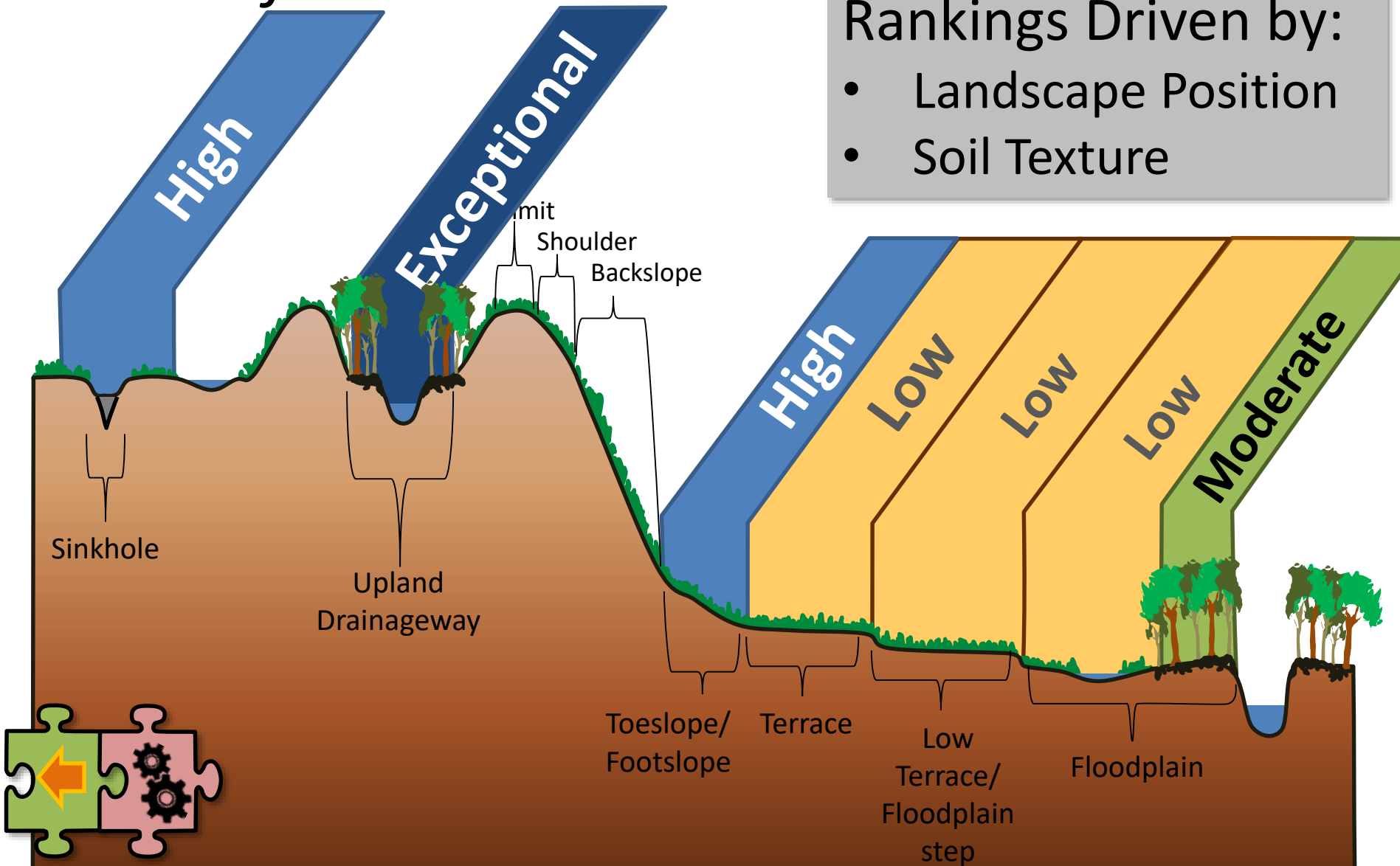


# Missouri Bottomland Functions:

## *Streamflow Maintenance*

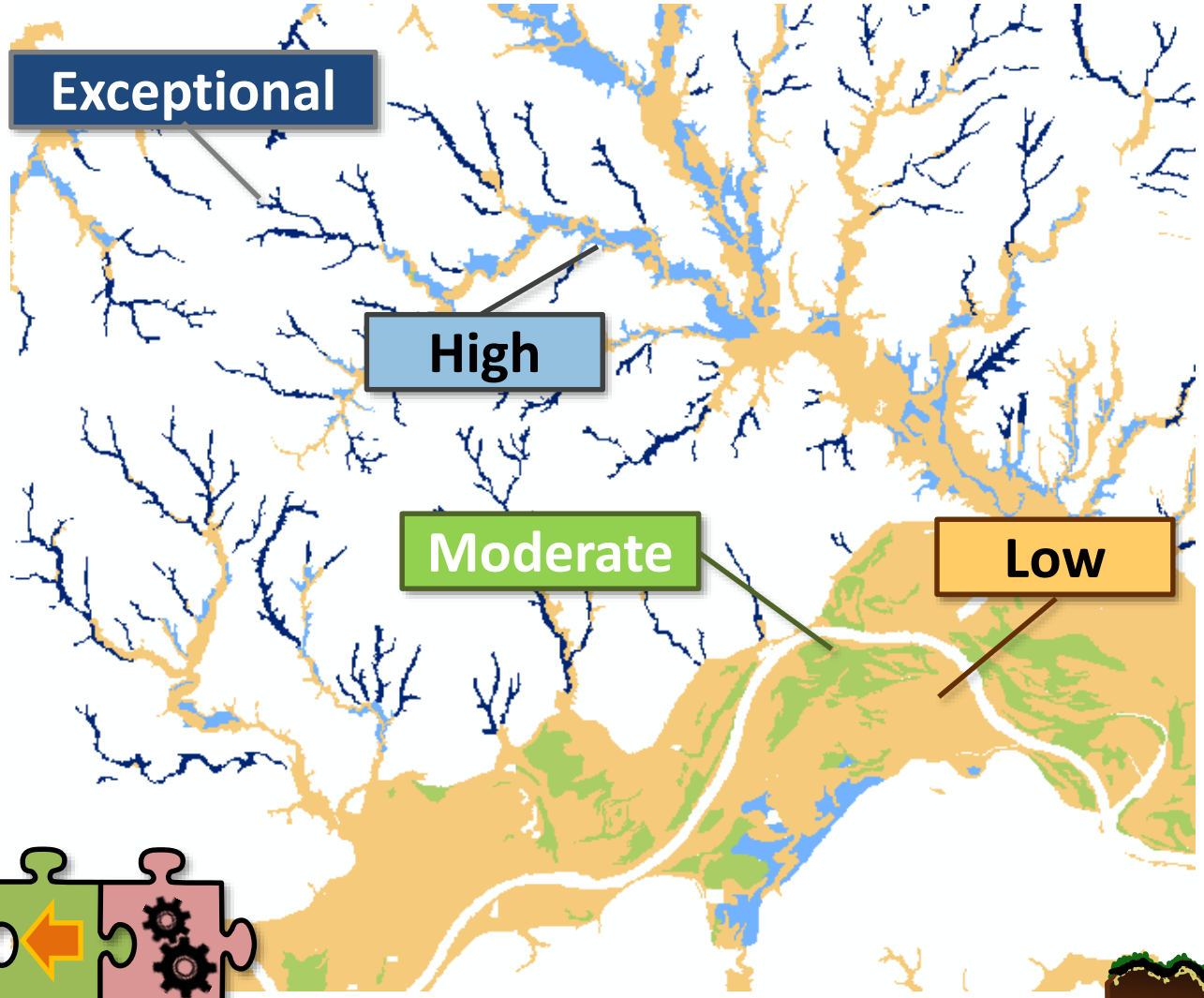
Rankings Driven by:

- Landscape Position
- Soil Texture



# Missouri Bottomland Functions:

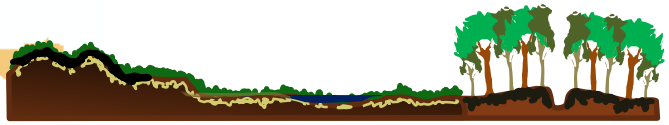
## *Streamflow Maintenance*




Discharge Locations

Higher in Watershed

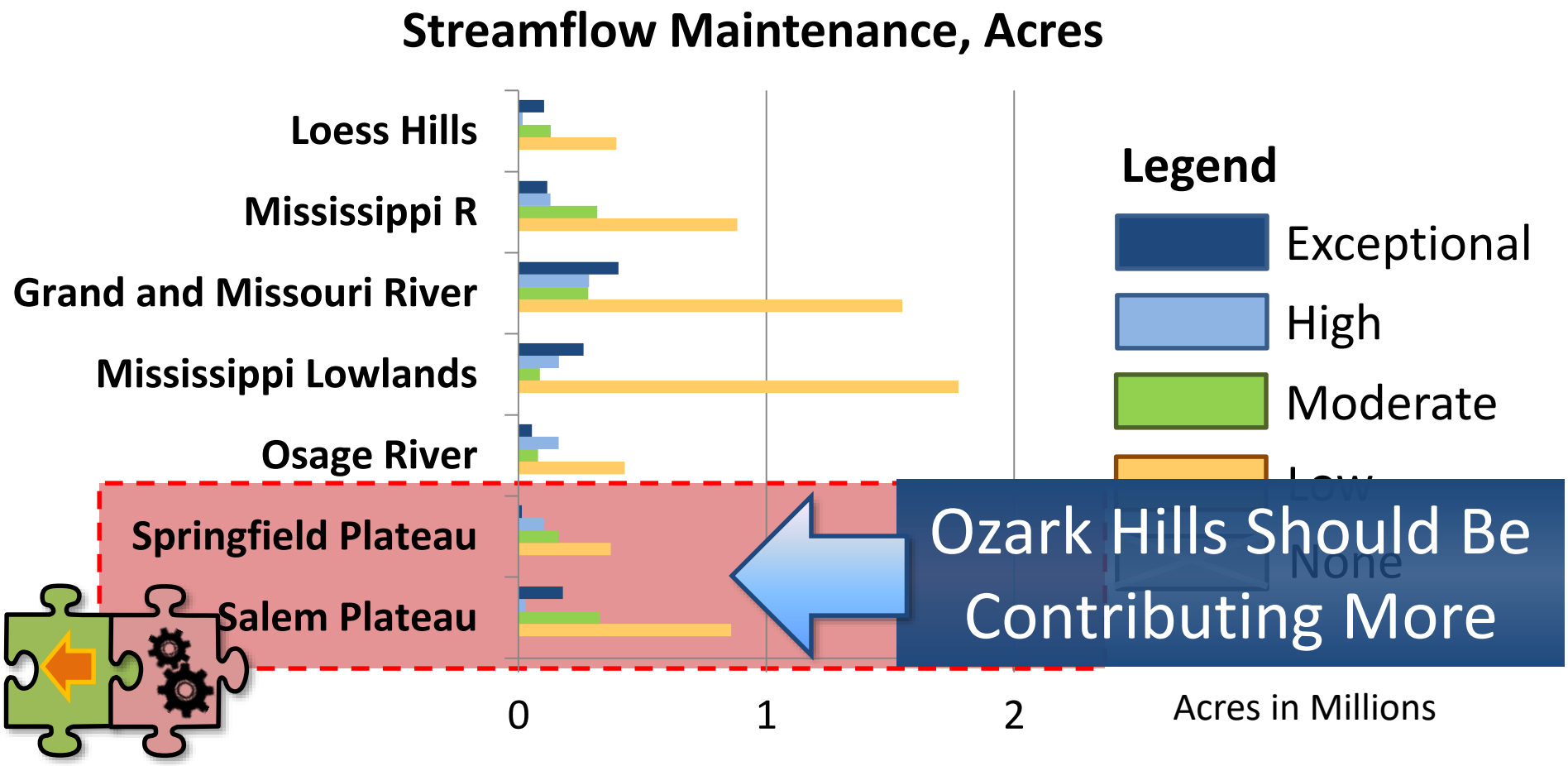




# Missouri Bottomland Functions:

*Streamflow Maintenance*

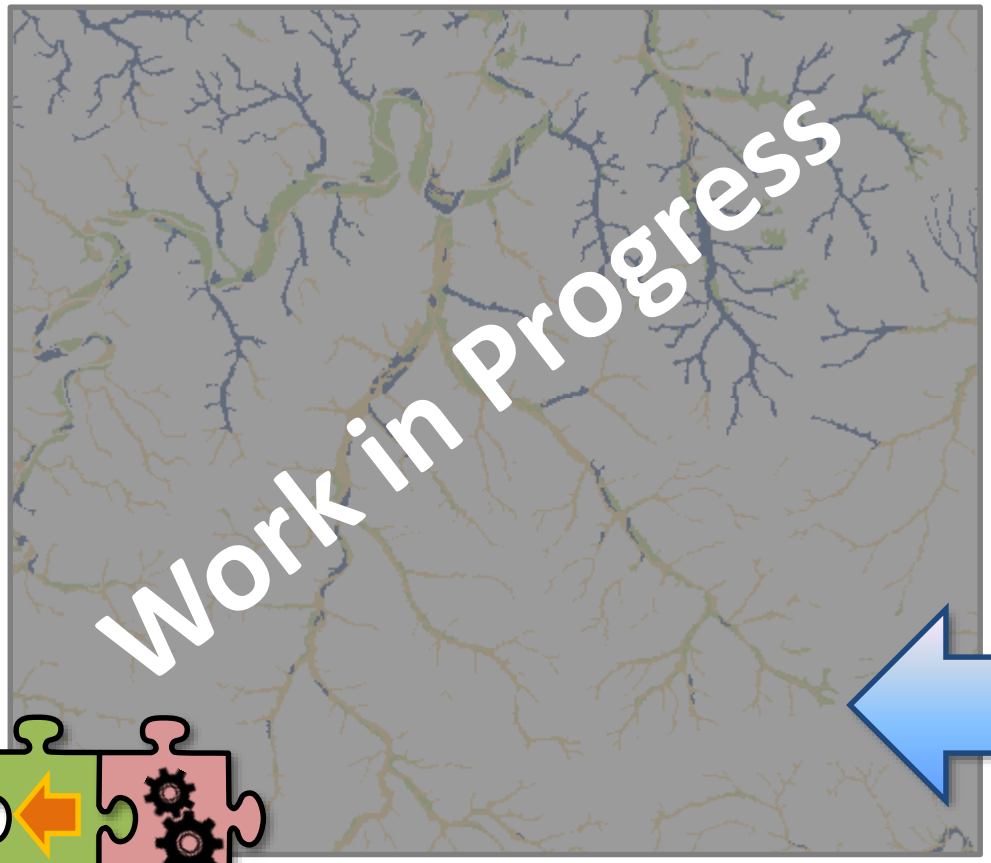
## Preliminary Results for Historic Potential



# Missouri Bottomland Functions:

*Streamflow Maintenance*

## Preliminary Results for Historic Potential




May need to link soils data to adjacent stream order

**Legend**

- Exceptional
- High
- Moderate
- Low
- None

Ozark Hills Should Be Contributing More

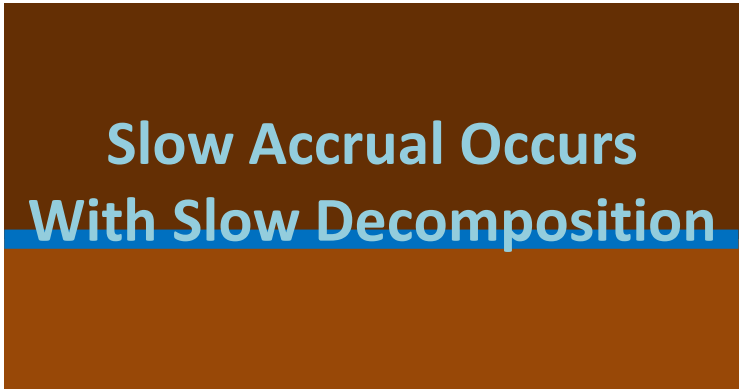
But not in others

# Missouri Bottomland Functions:

*Carbon Sequestration*

## Major Drivers

- Organic Soils
  - Geologic Timescale




**Under Continually Flooded Conditions**

Organic soils only occur in Missouri in a few isolated locations and as inclusions within soil map units

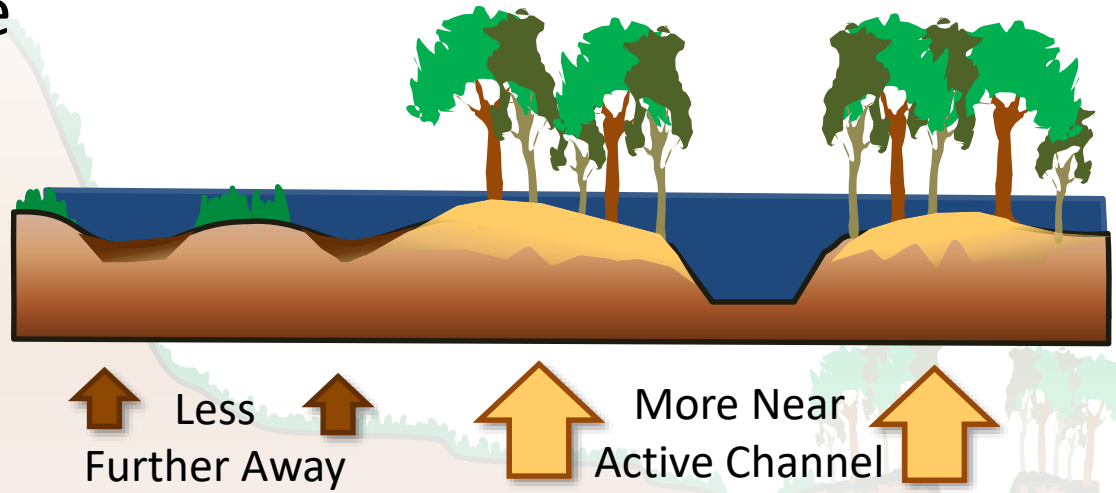
**However, Wettest Communities:**
Ponded Floodplain Prairie, Swamp, Ponded Sinkhole Wetlands, and Ozark Fens

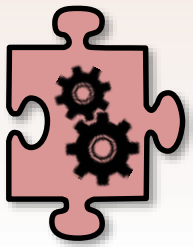
# Missouri Bottomland Functions:

*Carbon Sequestration*

## Major Drivers

- Organic Soils
  - Geologic Timescale
- Mineral Soils
  - Sedimentation



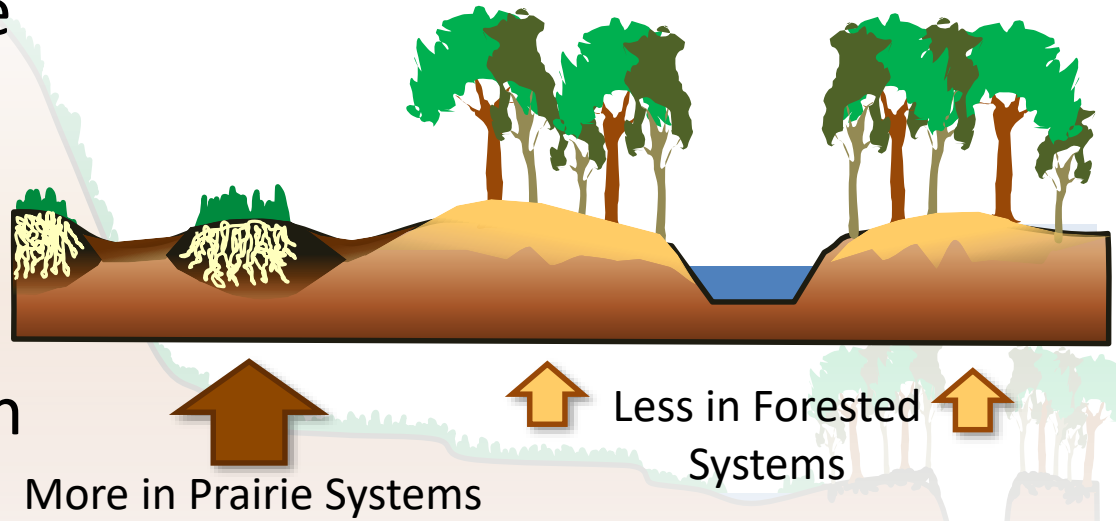



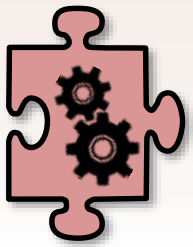
# Missouri Bottomland Functions:

*Carbon Sequestration*

## Major Drivers

- Organic Soils
  - Geologic Timescale
- Mineral Soils
  - Sedimentation
  - Soil Organic Carbon



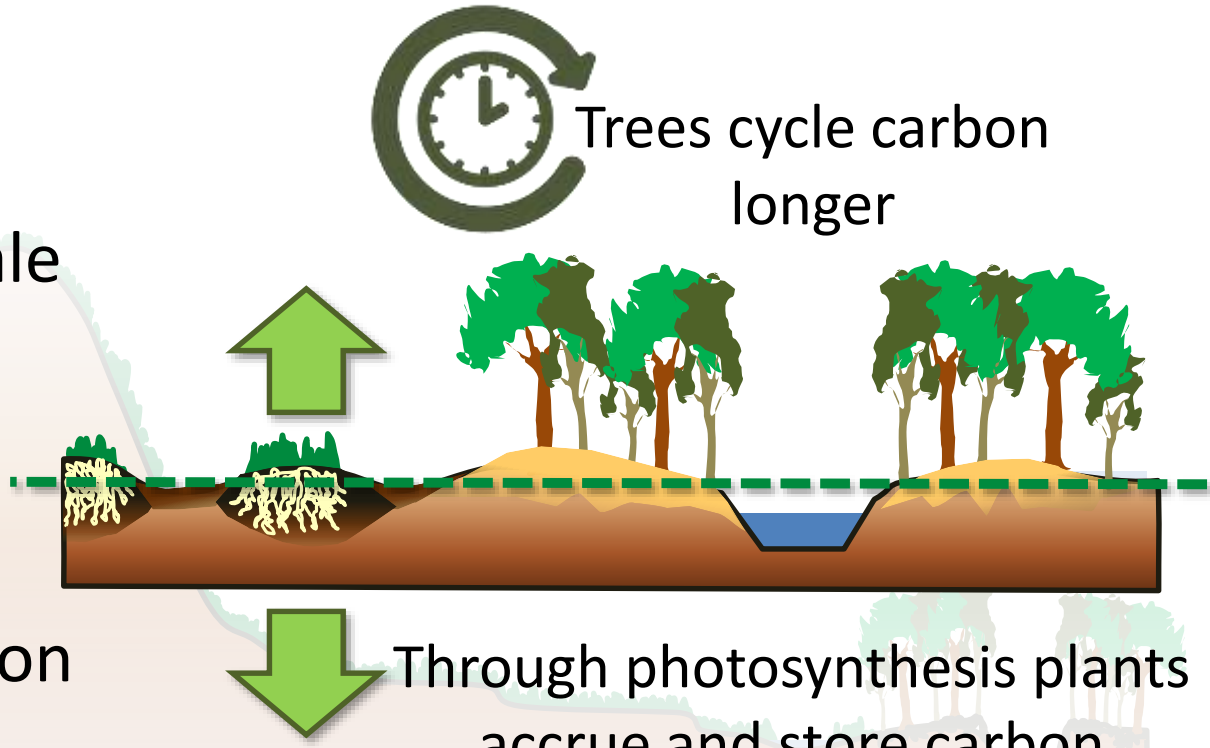



# Missouri Bottomland Functions:

*Carbon Sequestration*

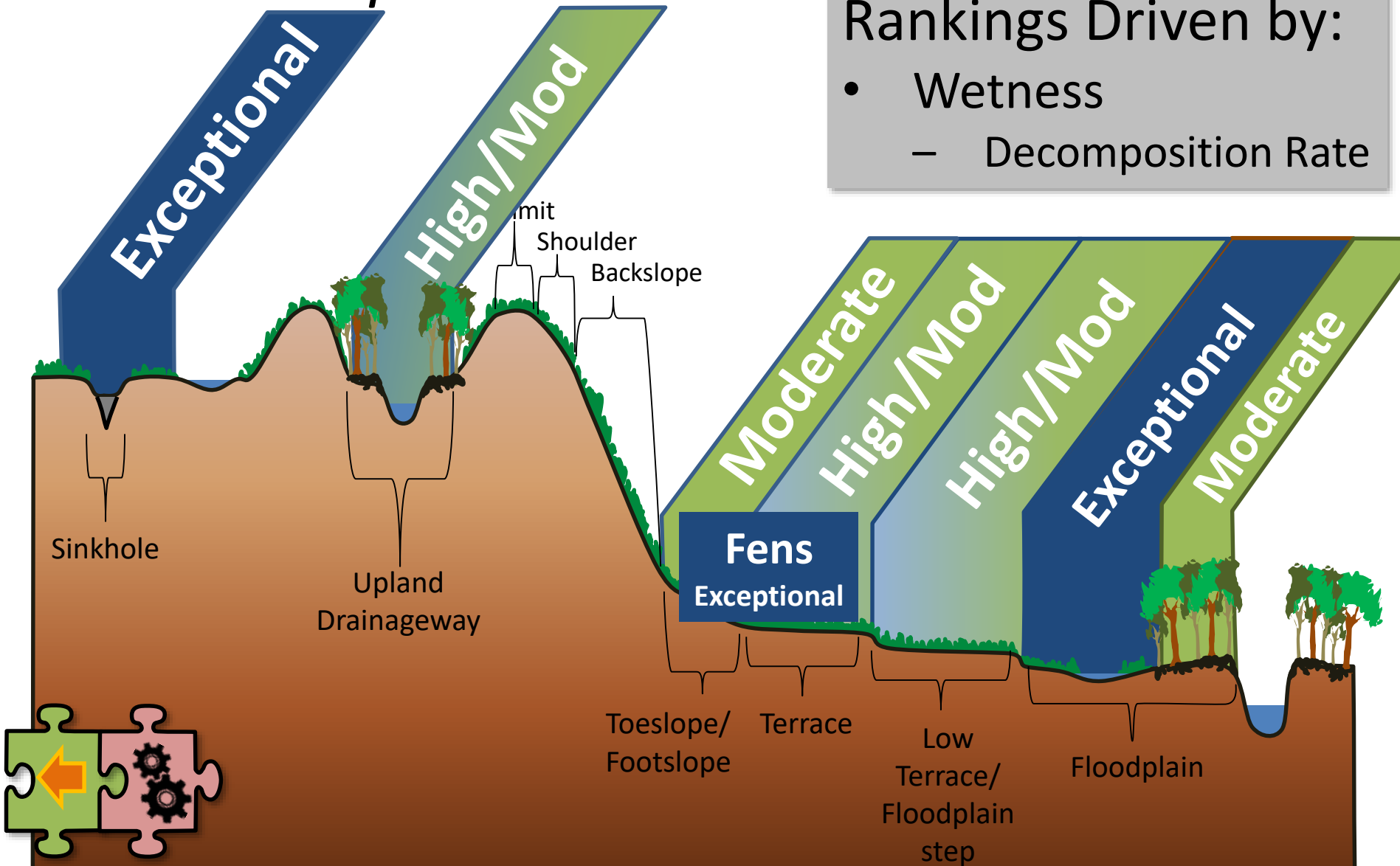
## Major Drivers

- Organic Soils
  - Geologic Timescale
- Mineral Soils
  - Sedimentation
  - Soil Organic Carbon
- Phytomass



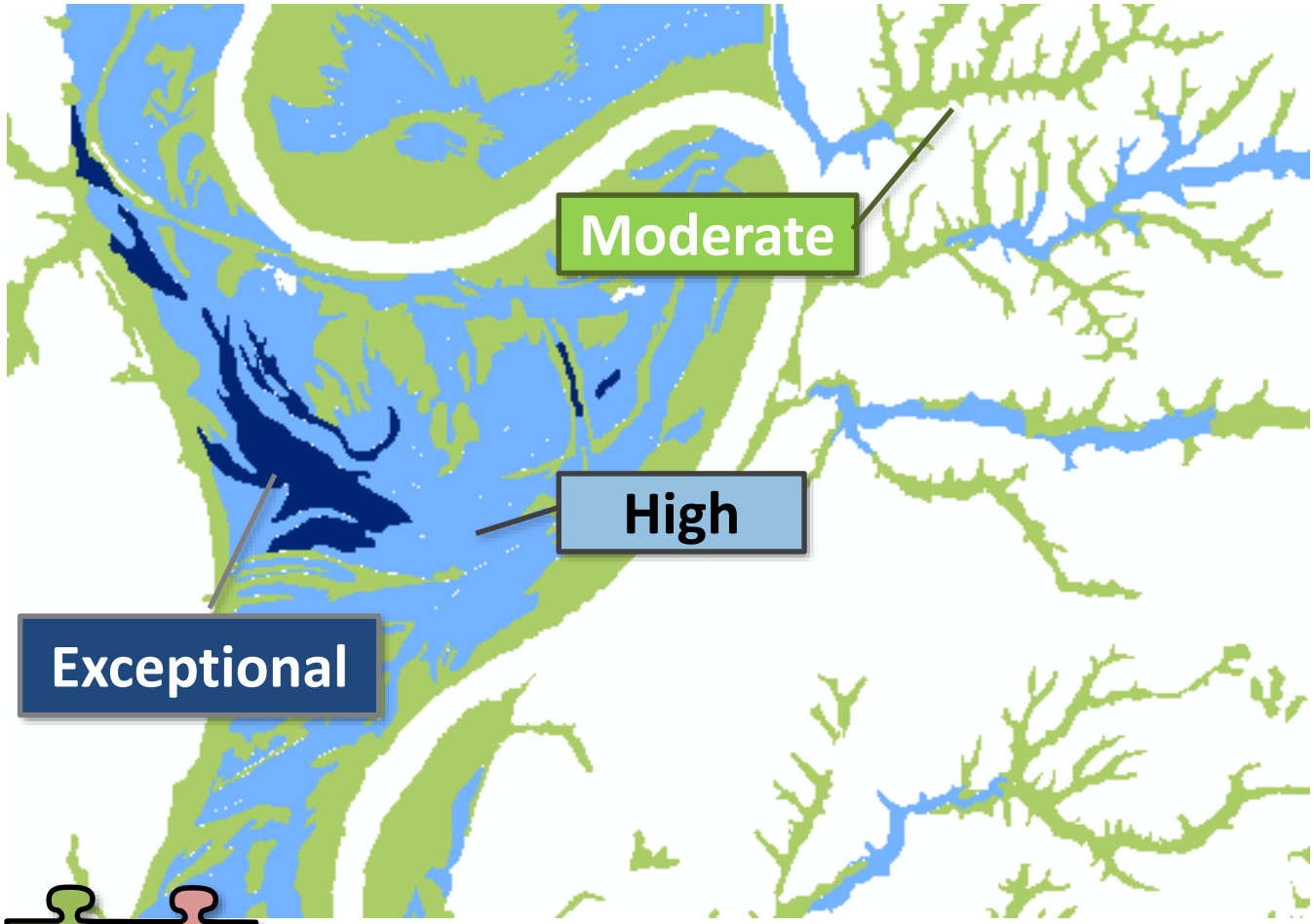
# Missouri Bottomland Functions:

## *Carbon Sequestration*

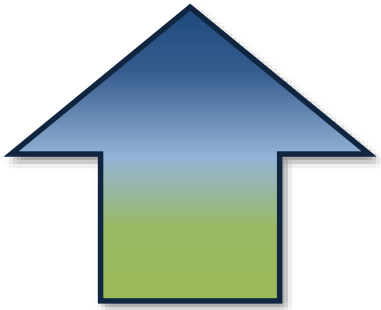


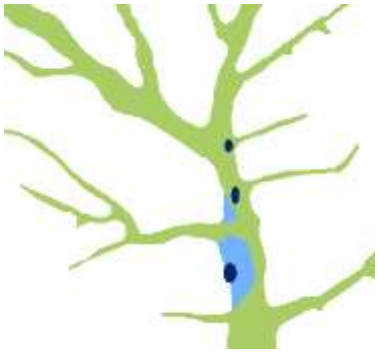
# Missouri Bottomland Functions:

## *Carbon Sequestration*

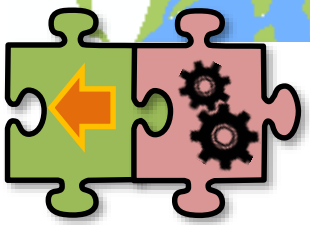



Wetness &
Plant Cover





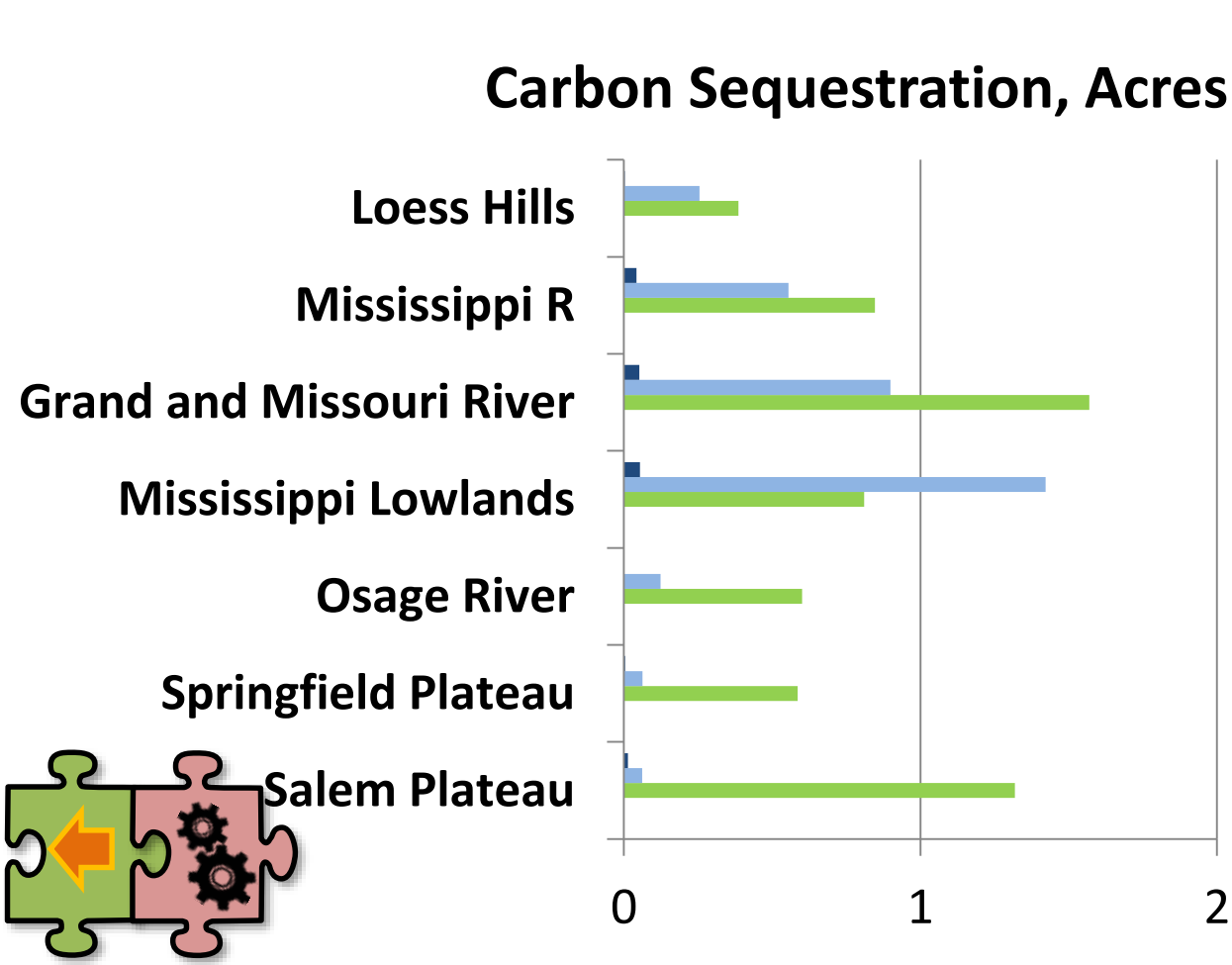
Captures Ozark Fen
Contributions



# Missouri Bottomland Functions:

*Carbon Sequestration*

## Preliminary Results for Historic Potential




Size/Acres is wrong metric to highlight Ozark fens, islands of carbon

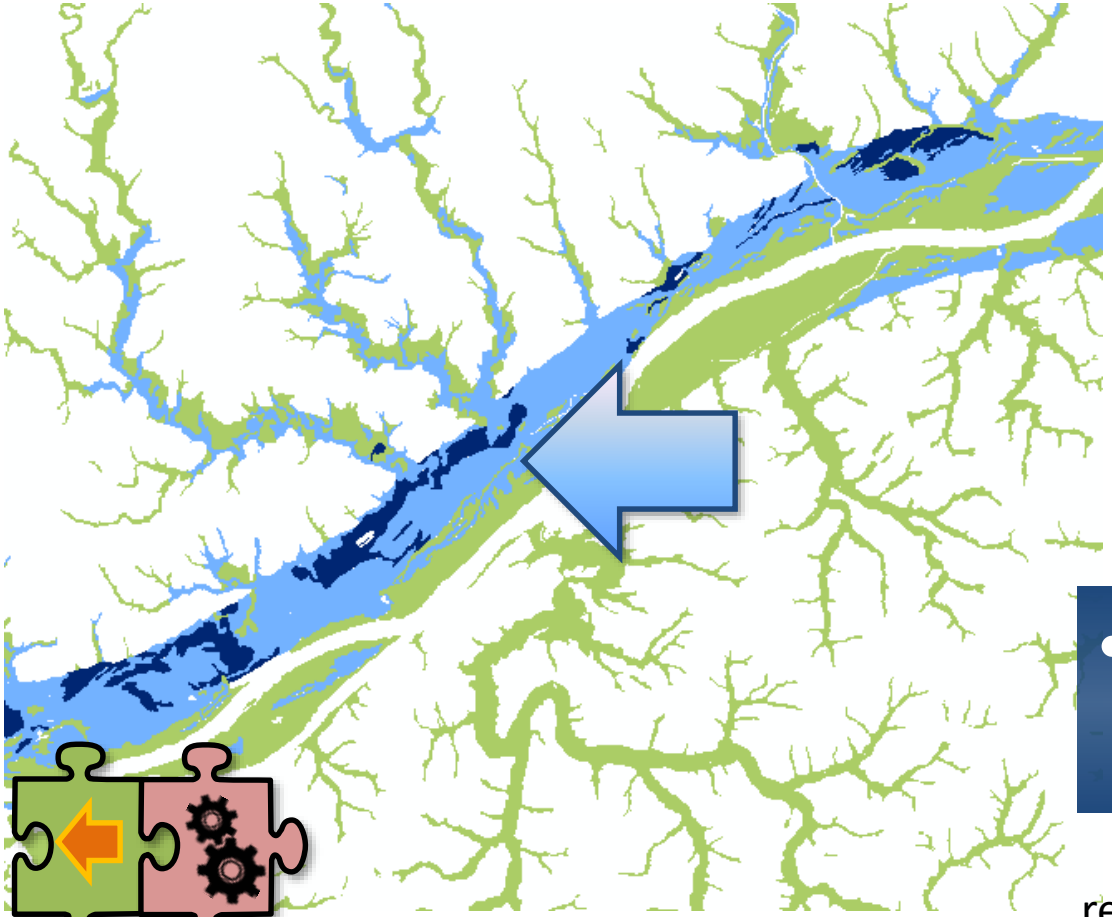
**Legend**

- Exceptional
- High
- Moderate
- Low
- None

# Missouri Bottomland Functions:

*Carbon Sequestration*

## Preliminary Results for Historic Potential



**Missouri River**

**Legend**

- Exceptional
- High
- Moderate

- Perennial ponding at base/toe of hills

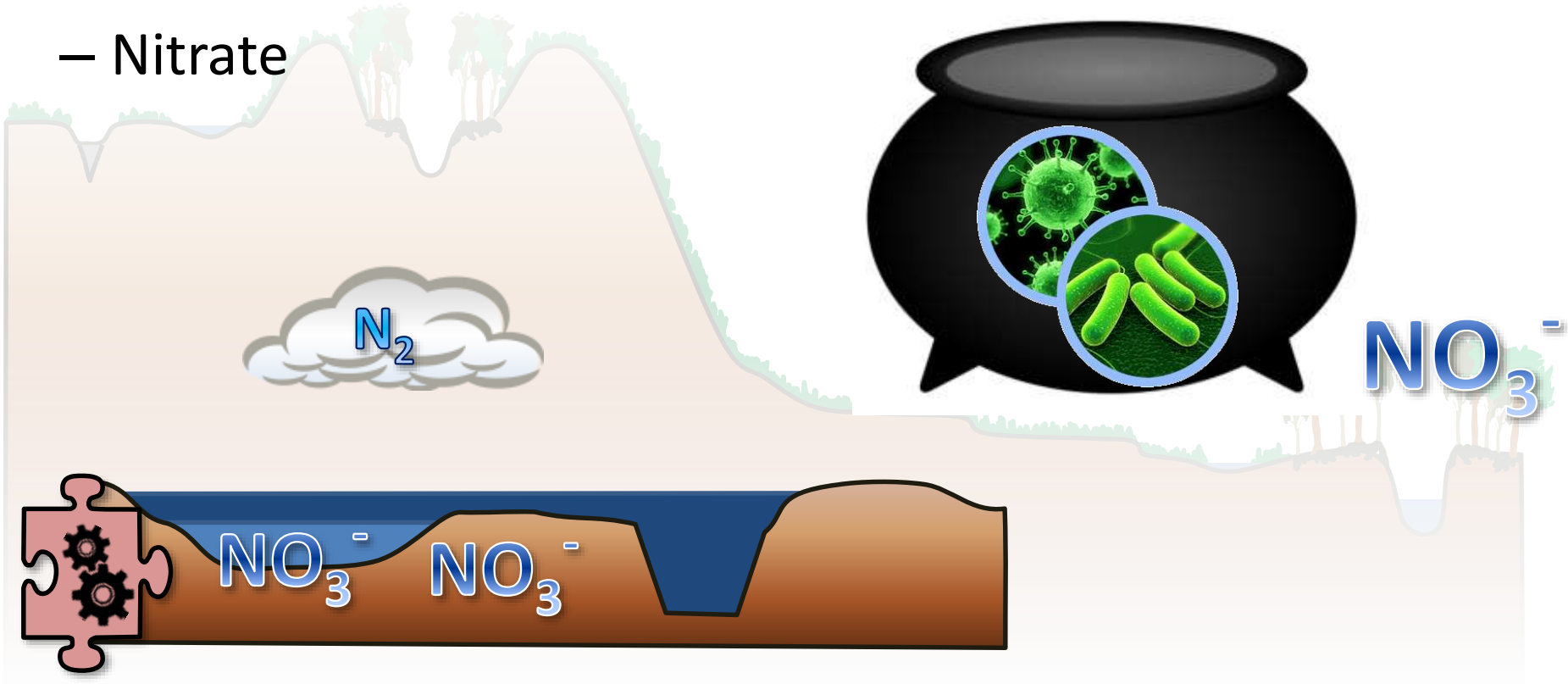
Mismatch with where wetland restoration can occur on public land

# Missouri Bottomland Functions:

*Nitrogen Reduction*

## Major Drivers

- Denitrification
  - Nitrate

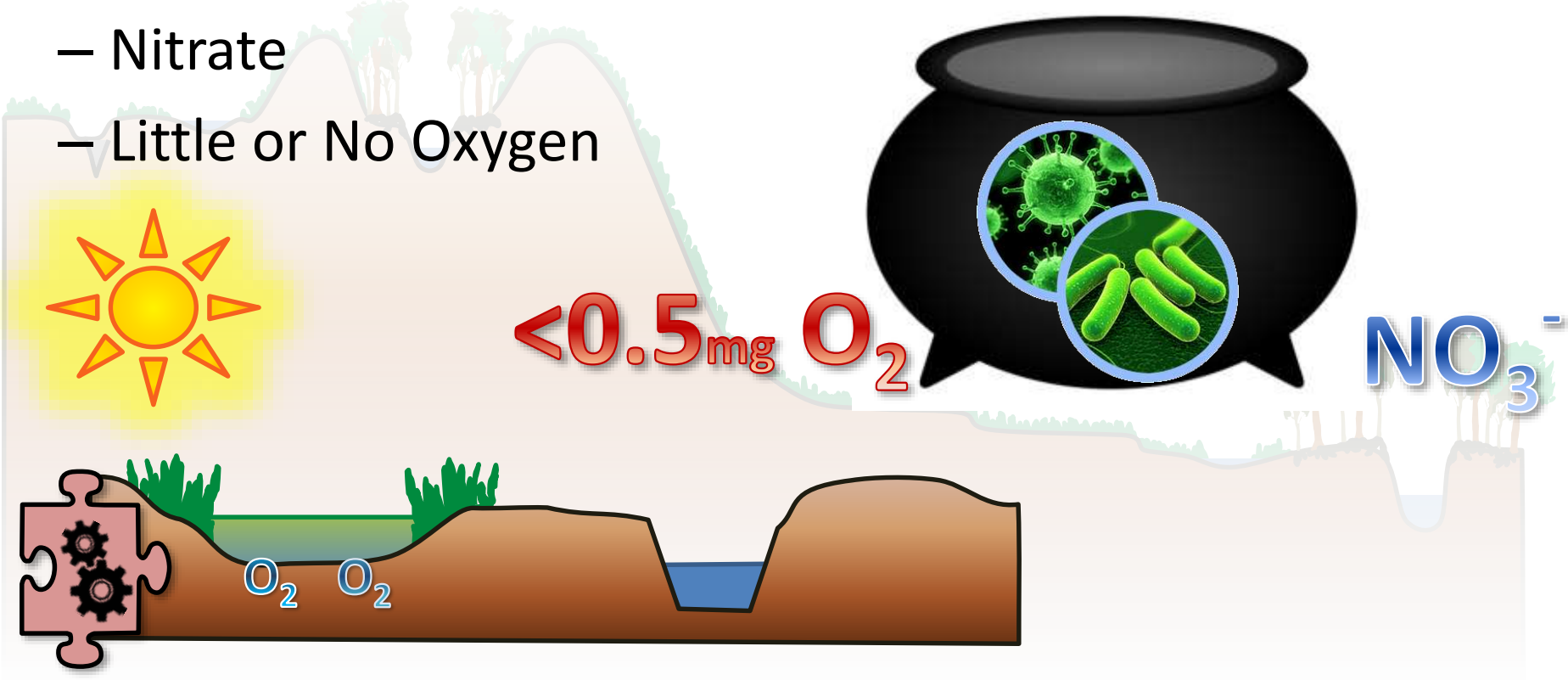


# Missouri Bottomland Functions:

*Nitrogen Reduction*

## Major Drivers

- Denitrification
  - Nitrate
  - Little or No Oxygen

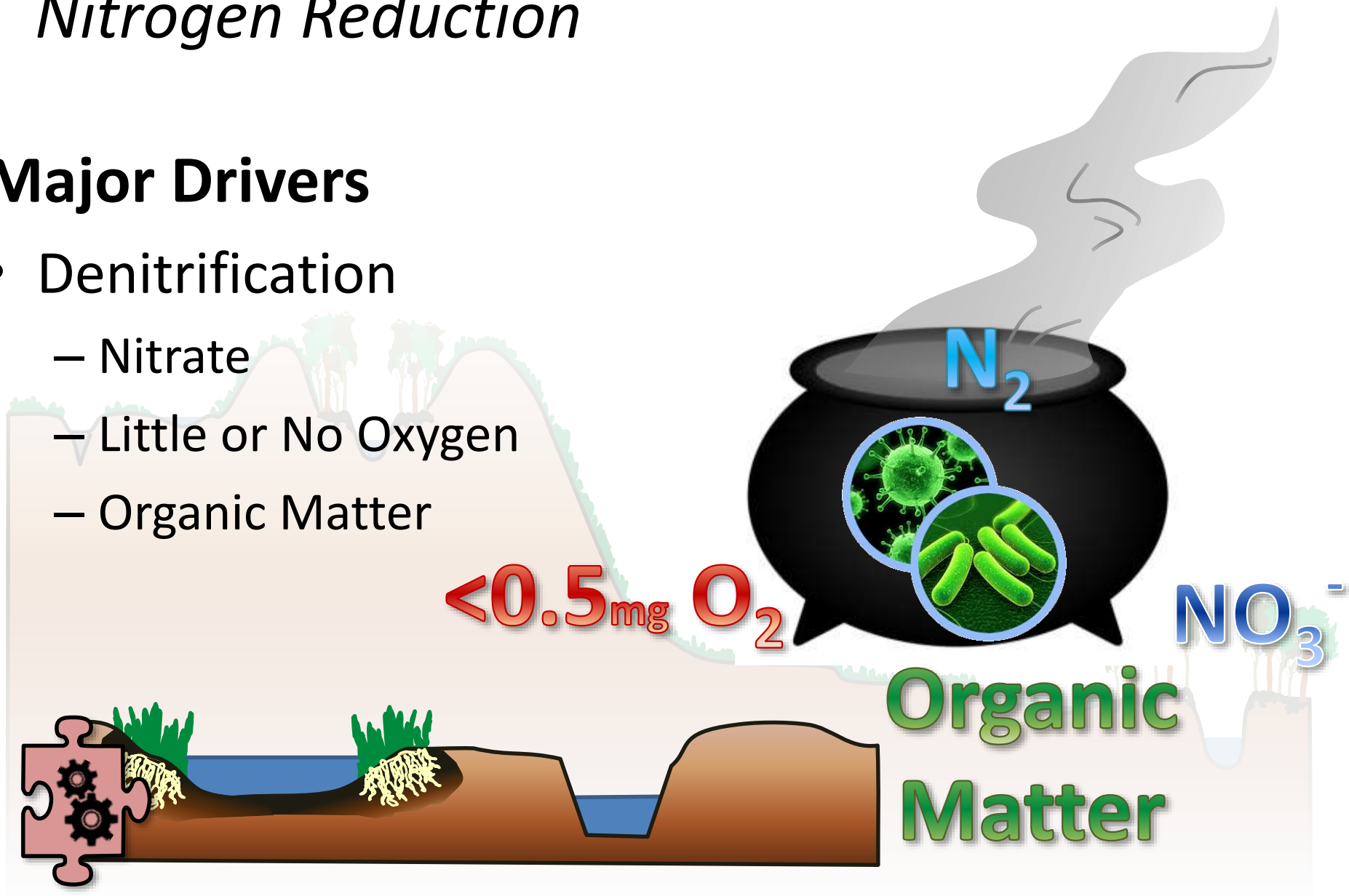


# Missouri Bottomland Functions:

*Nitrogen Reduction*

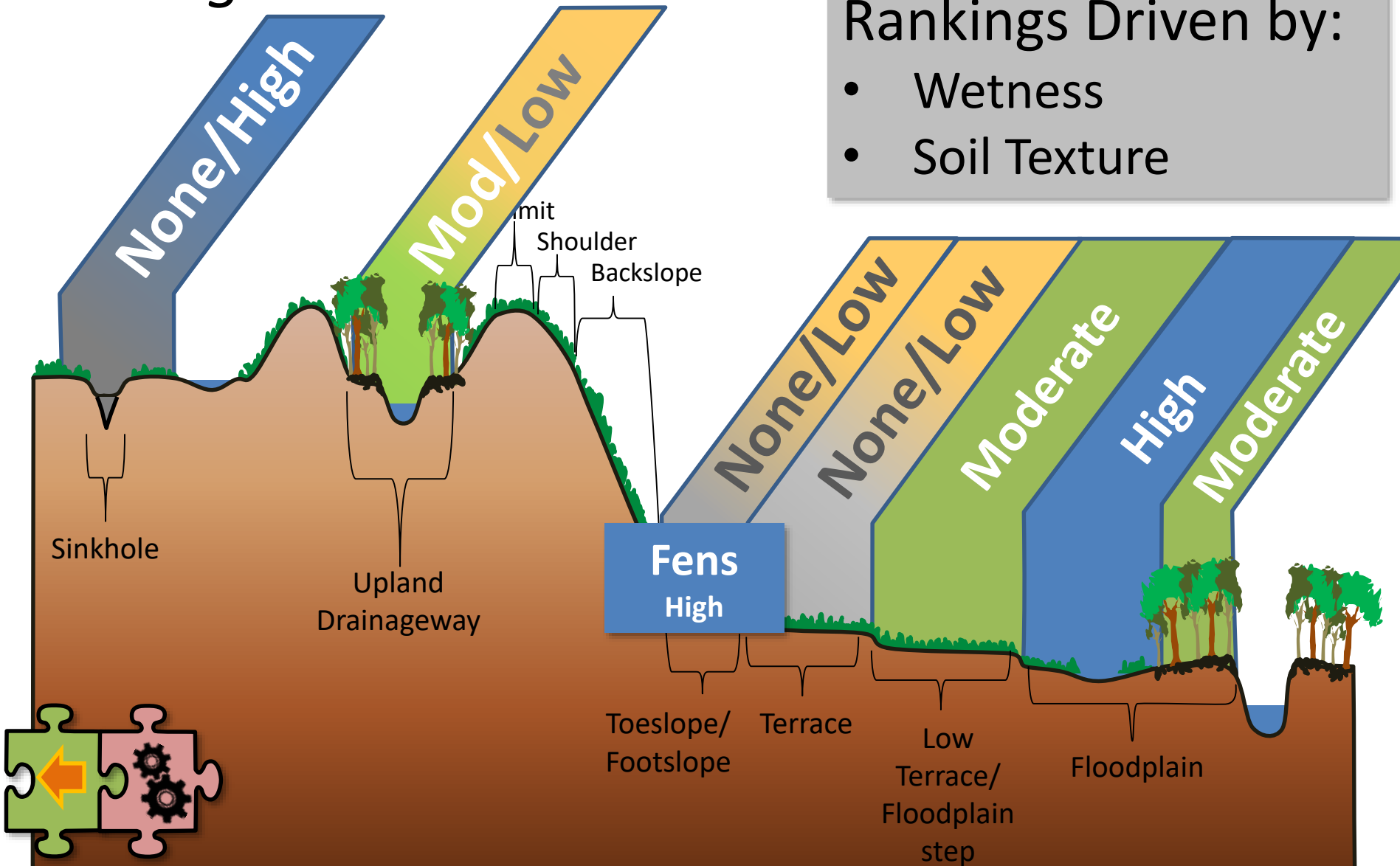
## Major Drivers

- Denitrification
  - Nitrate
  - Little or No Oxygen
  - Organic Matter



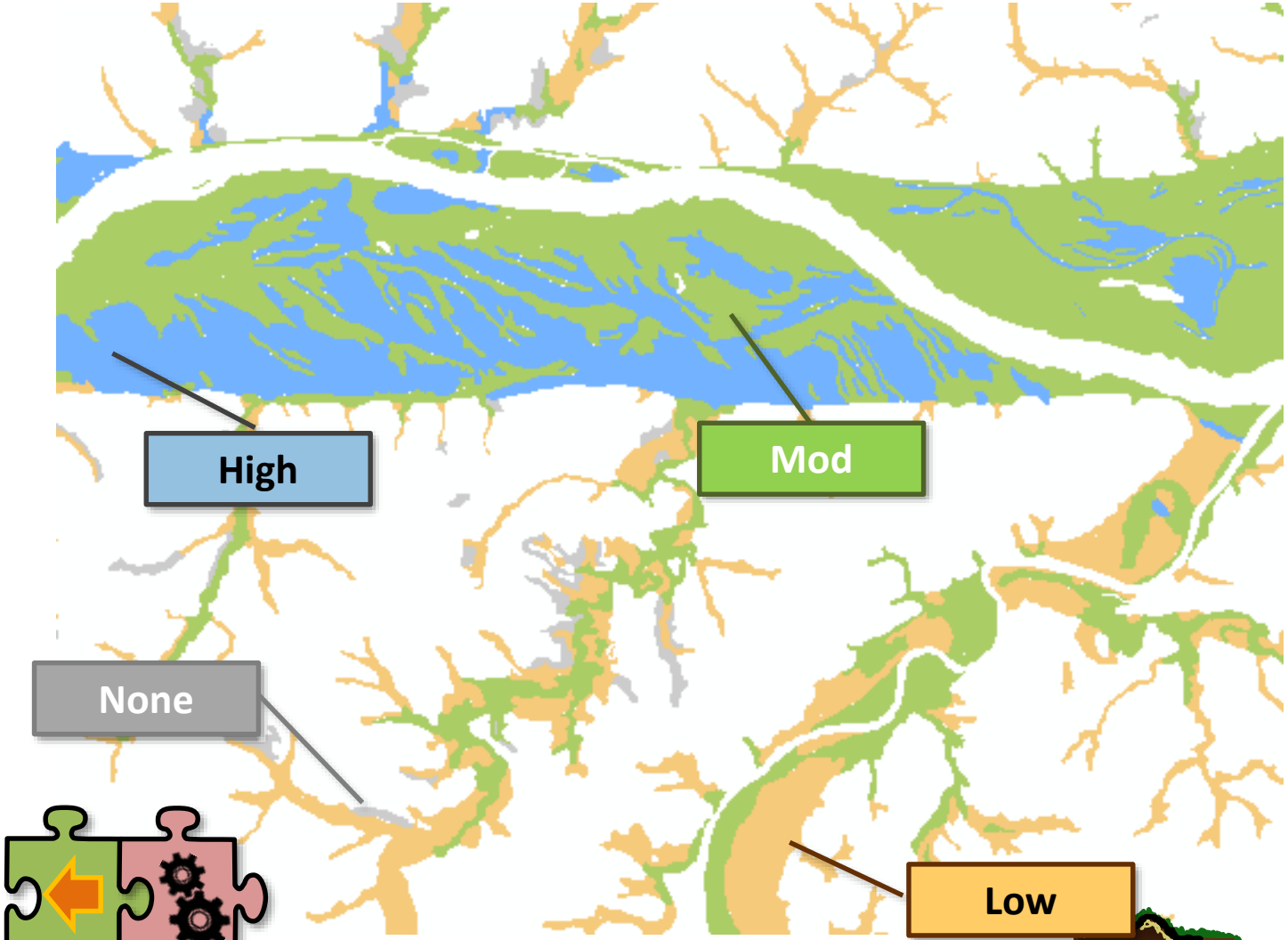
# Missouri Bottomland Functions:

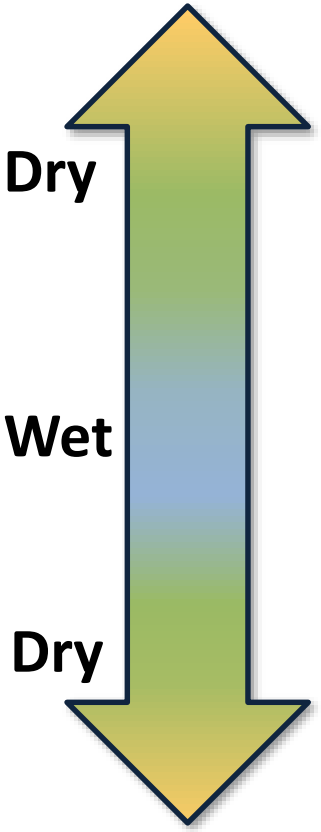
## *Nitrogen Reduction*



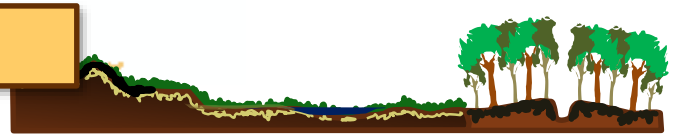
# Missouri Bottomland Functions:

## *Nitrogen Reduction*



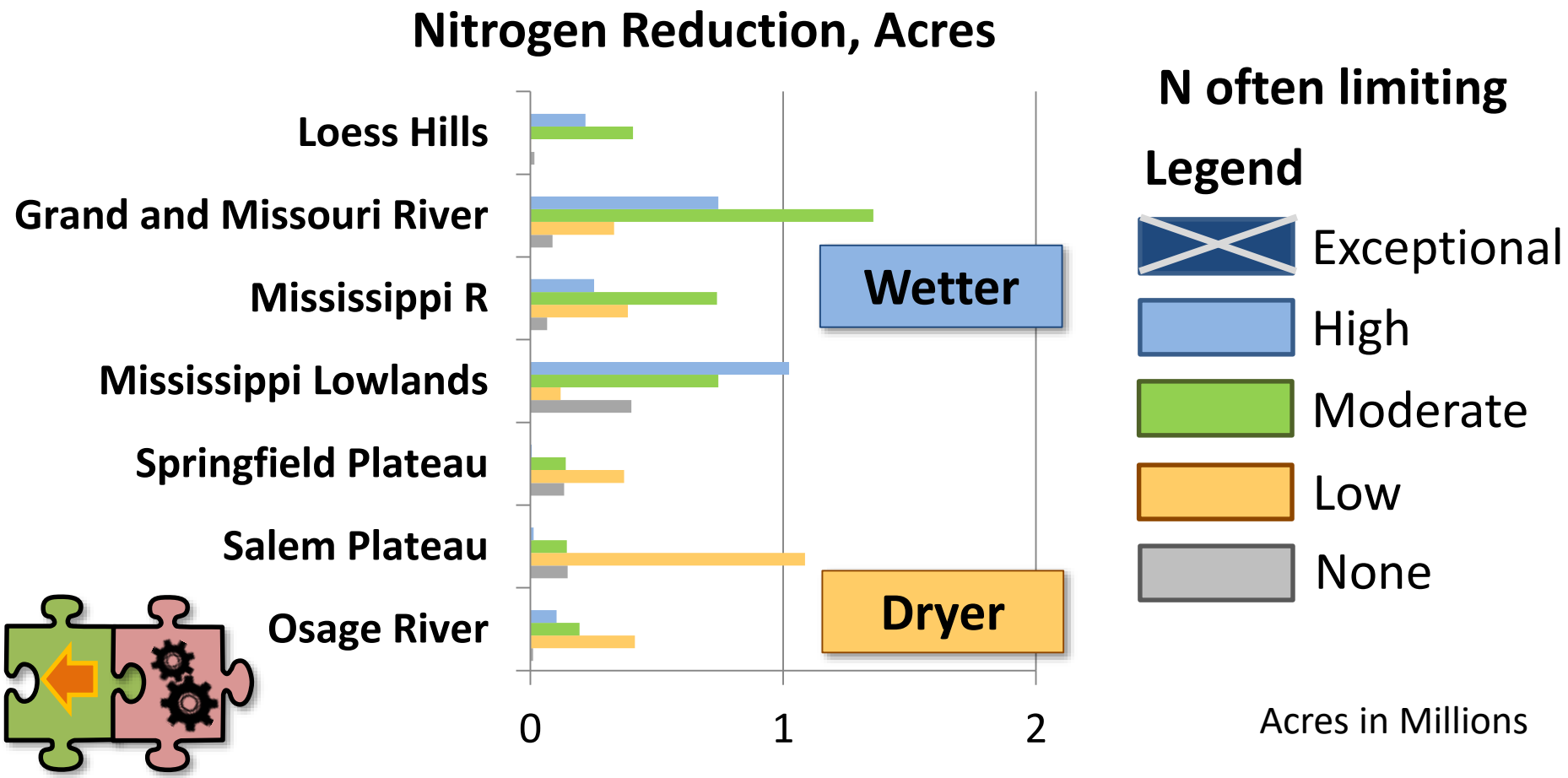


# Missouri Bottomland Functions:

## *Nitrogen Reduction*

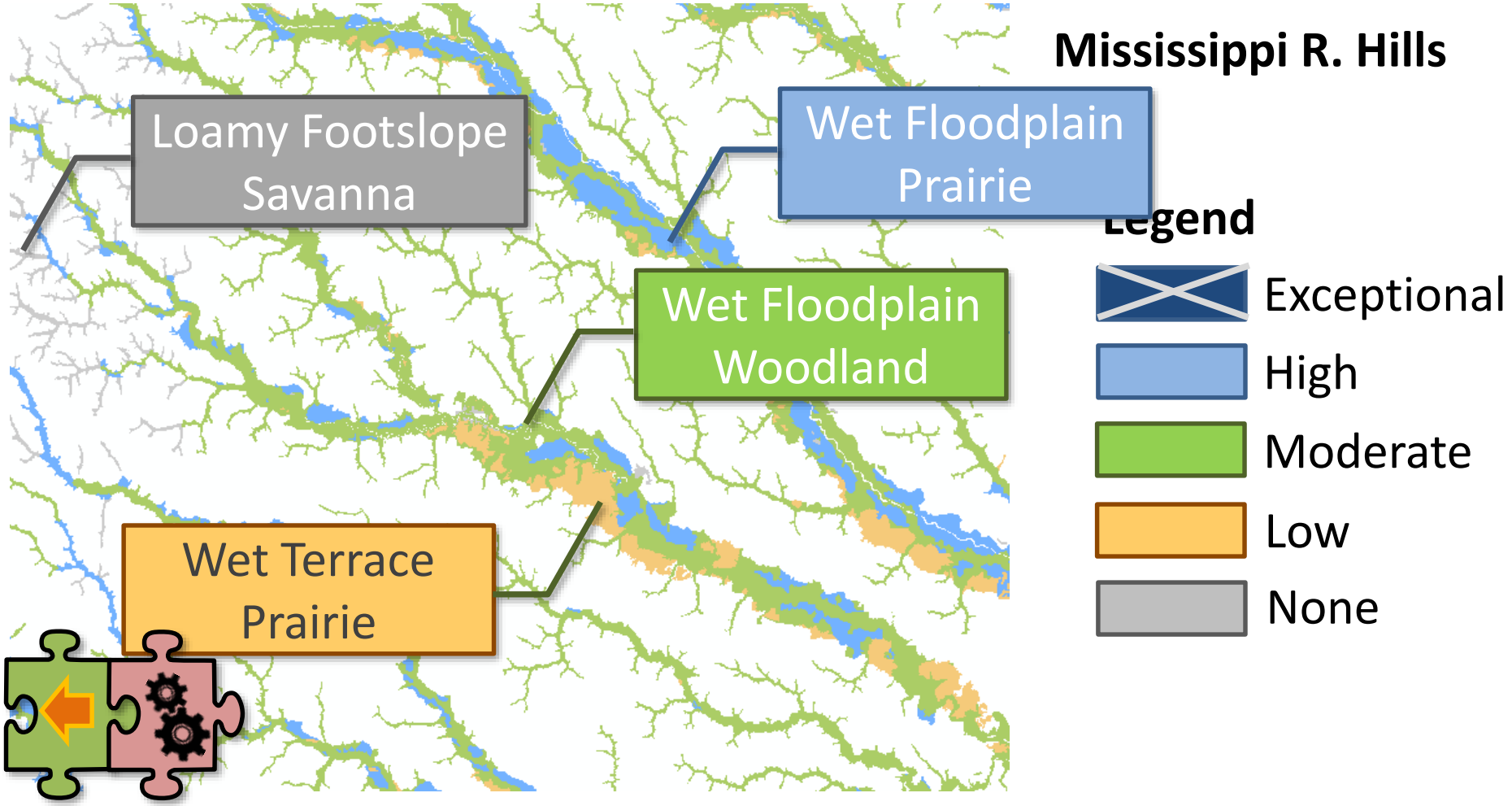
## Preliminary Results for Historic Potential



# Missouri Bottomland Functions:

*Nitrogen Reduction*

## Preliminary Results for Historic Potential



# Missouri Bottomland Functions:

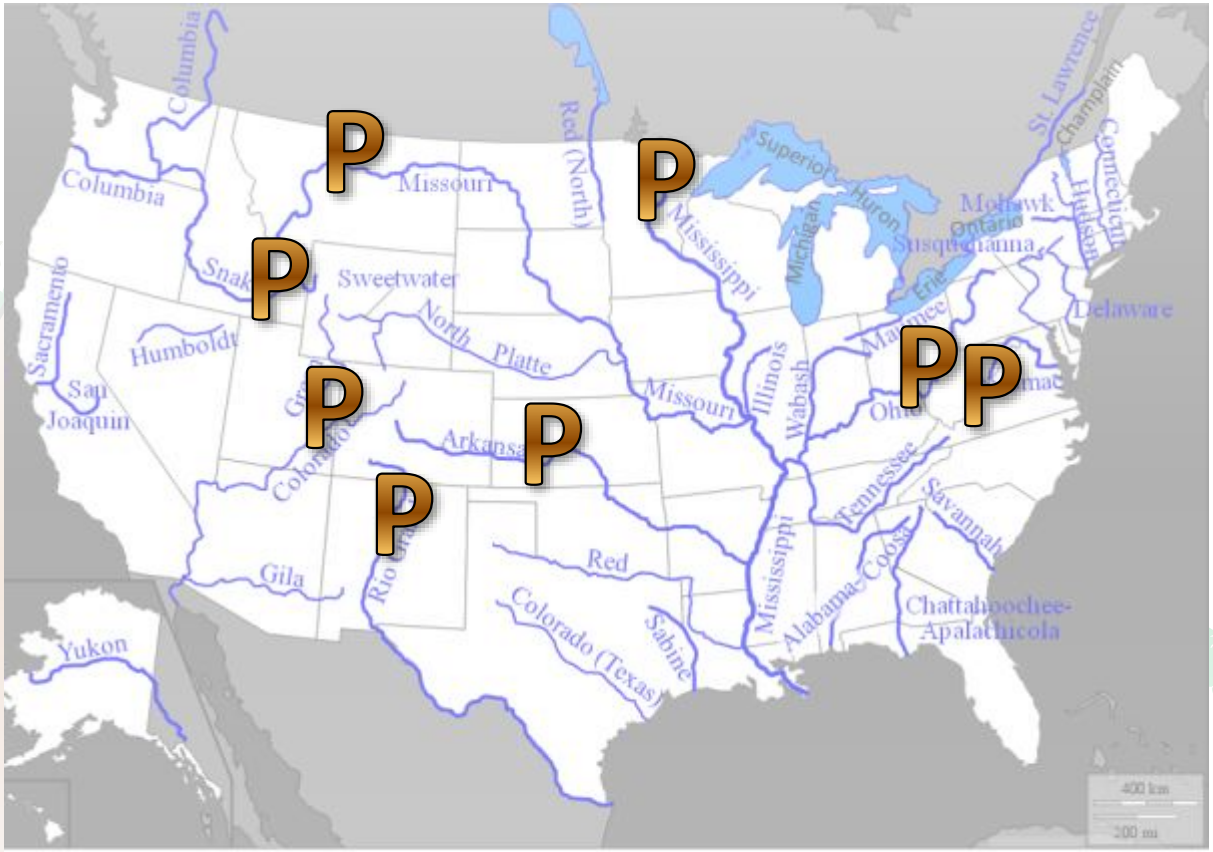
*Phosphorus Retention*

## Major Drivers

Different from cycling nitrogen and carbon

Phosphorus cycle occurs over a greater space and time scale

Weathering of rock and transport to ocean



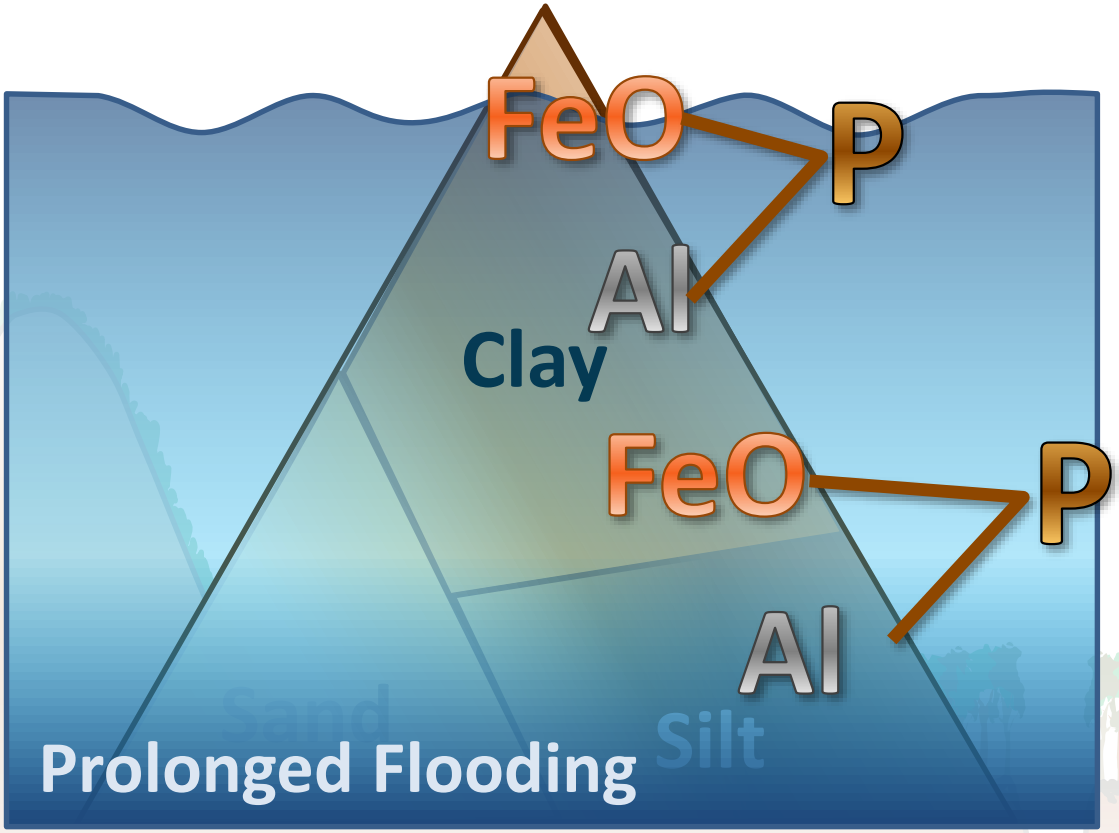

Major Rivers and Lakes Used for Migration in the United States

# Missouri Bottomland Functions:

*Phosphorus Retention*

## Major Drivers

- Binding to Soils
  - Mineral Soil



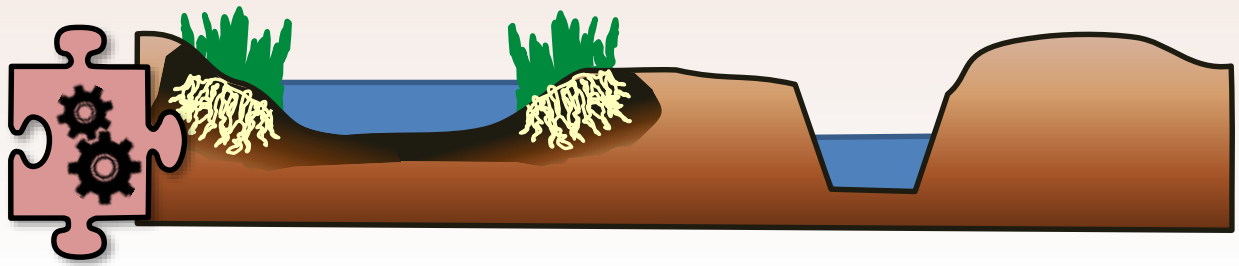
# Missouri Bottomland Functions:

*Phosphorus Retention*

## Major Drivers

- Binding to Soils
  - Mineral Soil
  - Organic Soil

P < Organic Matter > P



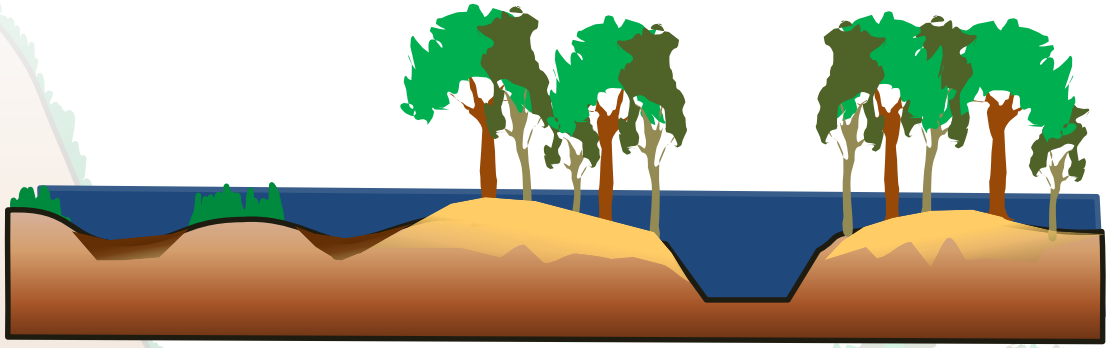
Longevity of Ozark Fens point to high P accrual

# Missouri Bottomland Functions:

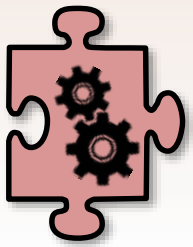
*Phosphorus Retention*

## Major Drivers

- Binding to Soils
  - Mineral
  - Organic
- Sedimentation



Way to bury soil bound phosphorus



# Missouri Bottomland Functions:

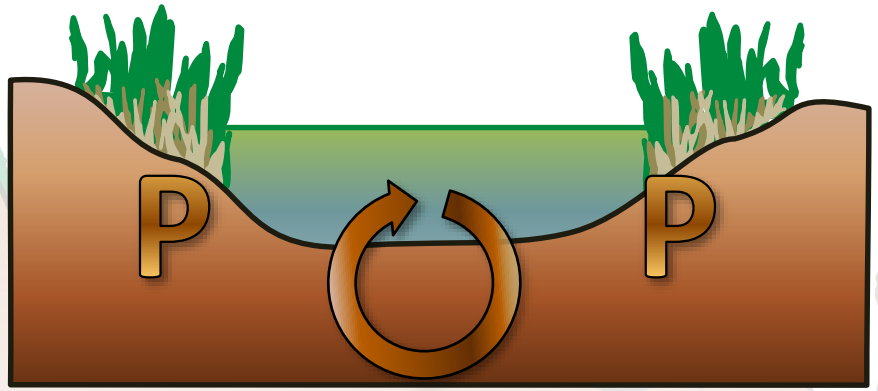
## *Phosphorus Retention*

### Major Drivers

- Binding to Soils
  - Mineral
  - Organic
- Sedimentation
- Biological Uptake

Growing Season

Dormant Season



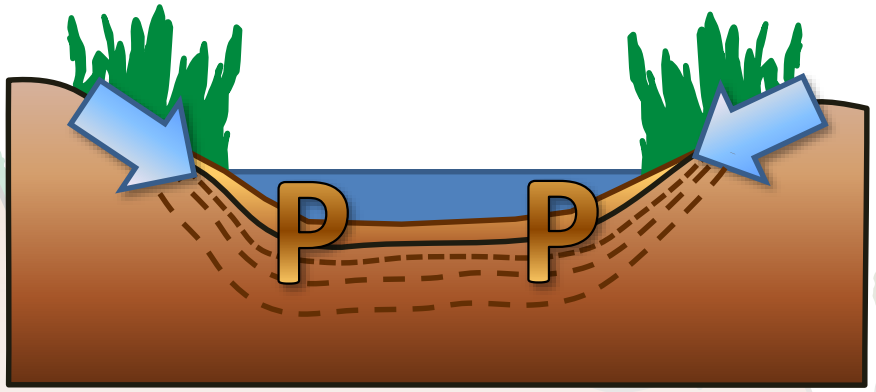

Plants retain P temporarily

# Missouri Bottomland Functions:

*Phosphorus Retention*

## Major Drivers

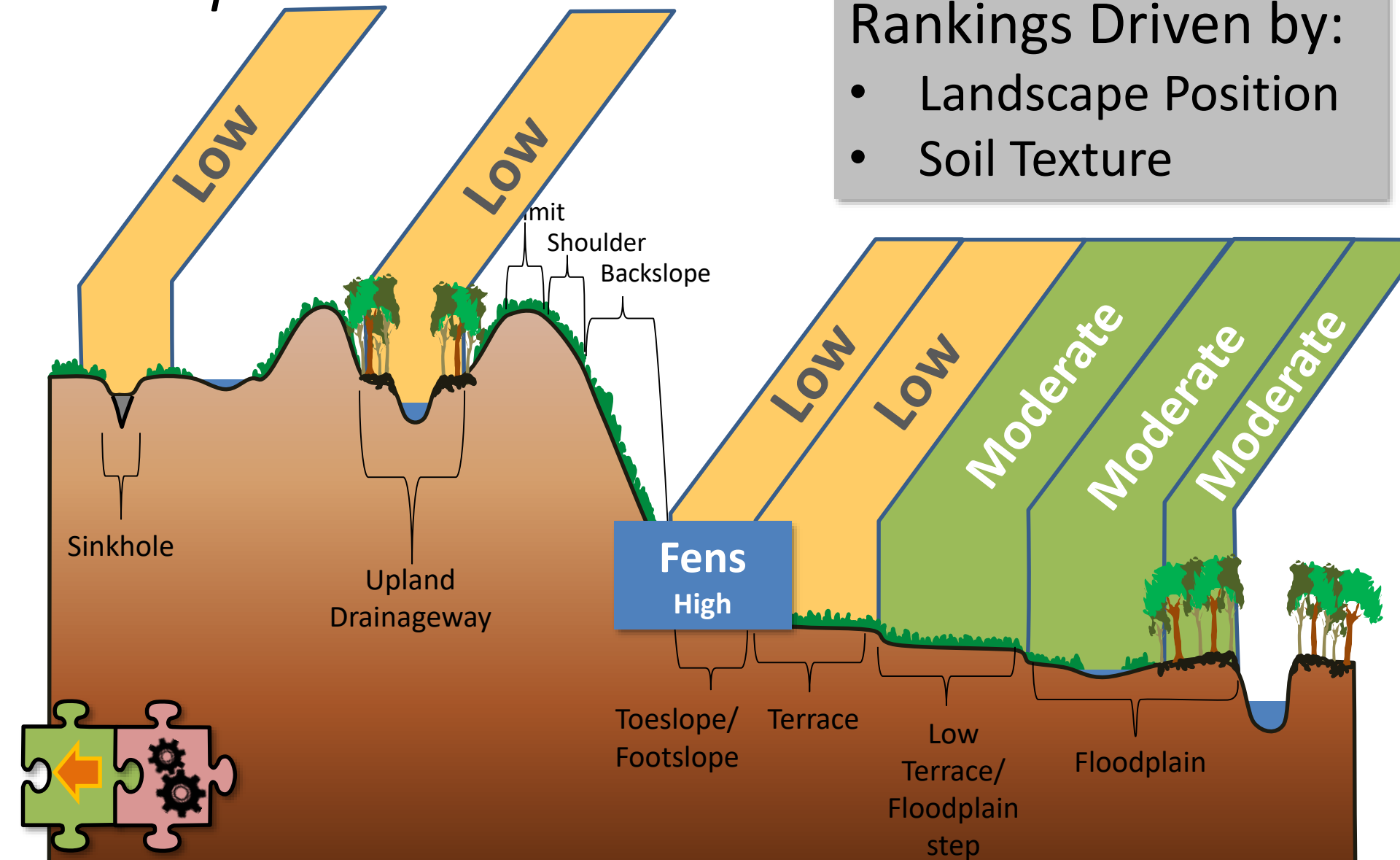
- Binding to Soils
  - Mineral
  - Organic
- Sedimentation
- Biological Uptake
  - Structure:
    - Slows velocity
    - Assists with sedimentation




Assist with burial of P

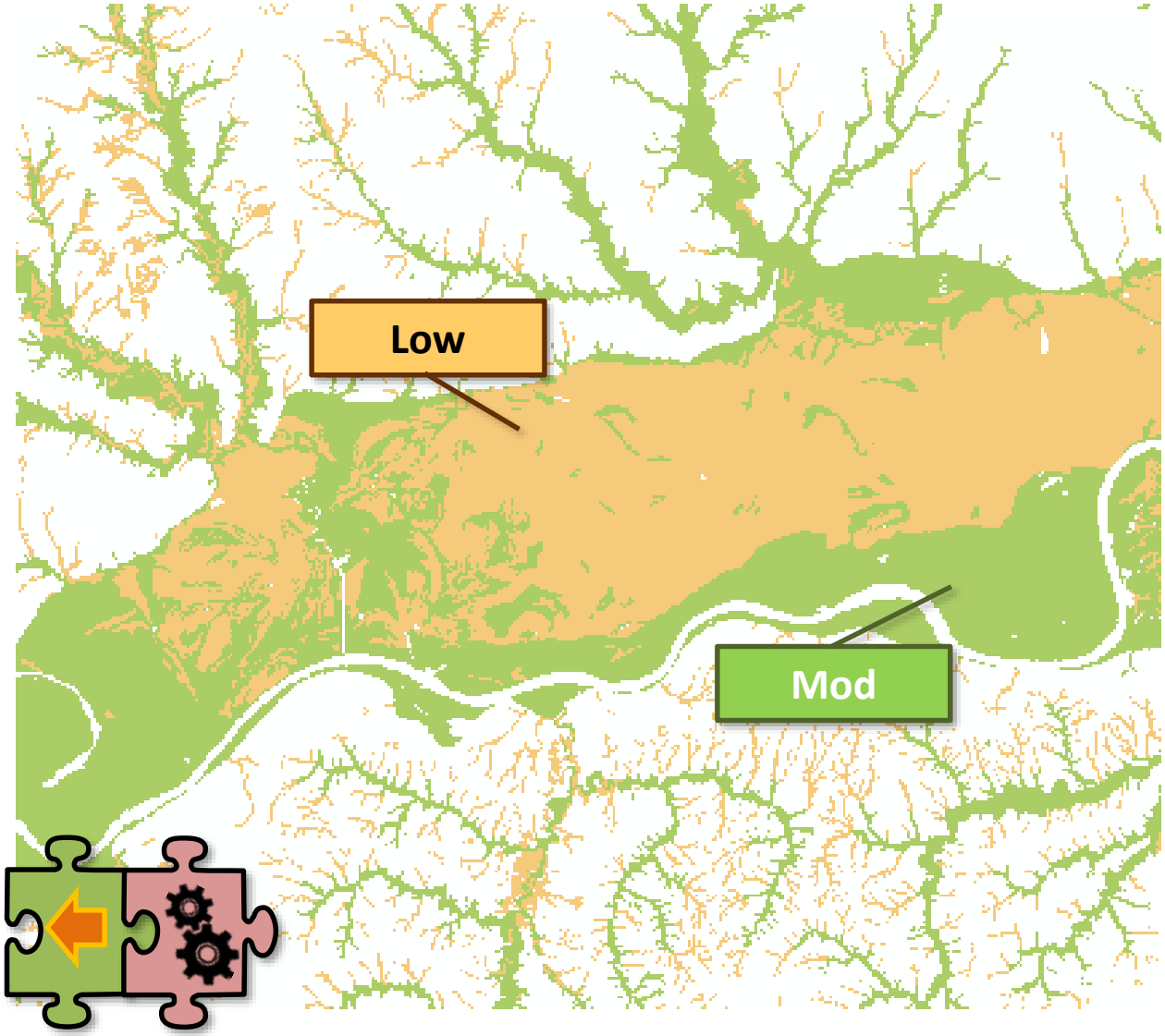
# Missouri Bottomland Functions:

## *Phosphorus Retention*

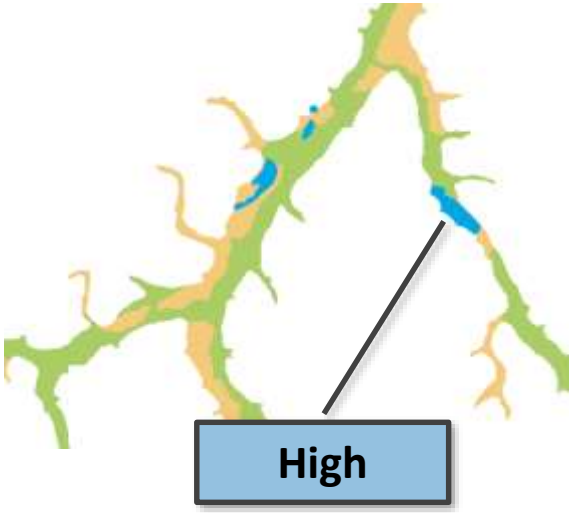


# Missouri Bottomland Functions:

## *Phosphorus Retention*




Potential where sedimentation may occur or *"wet-but-not-too-wet"*

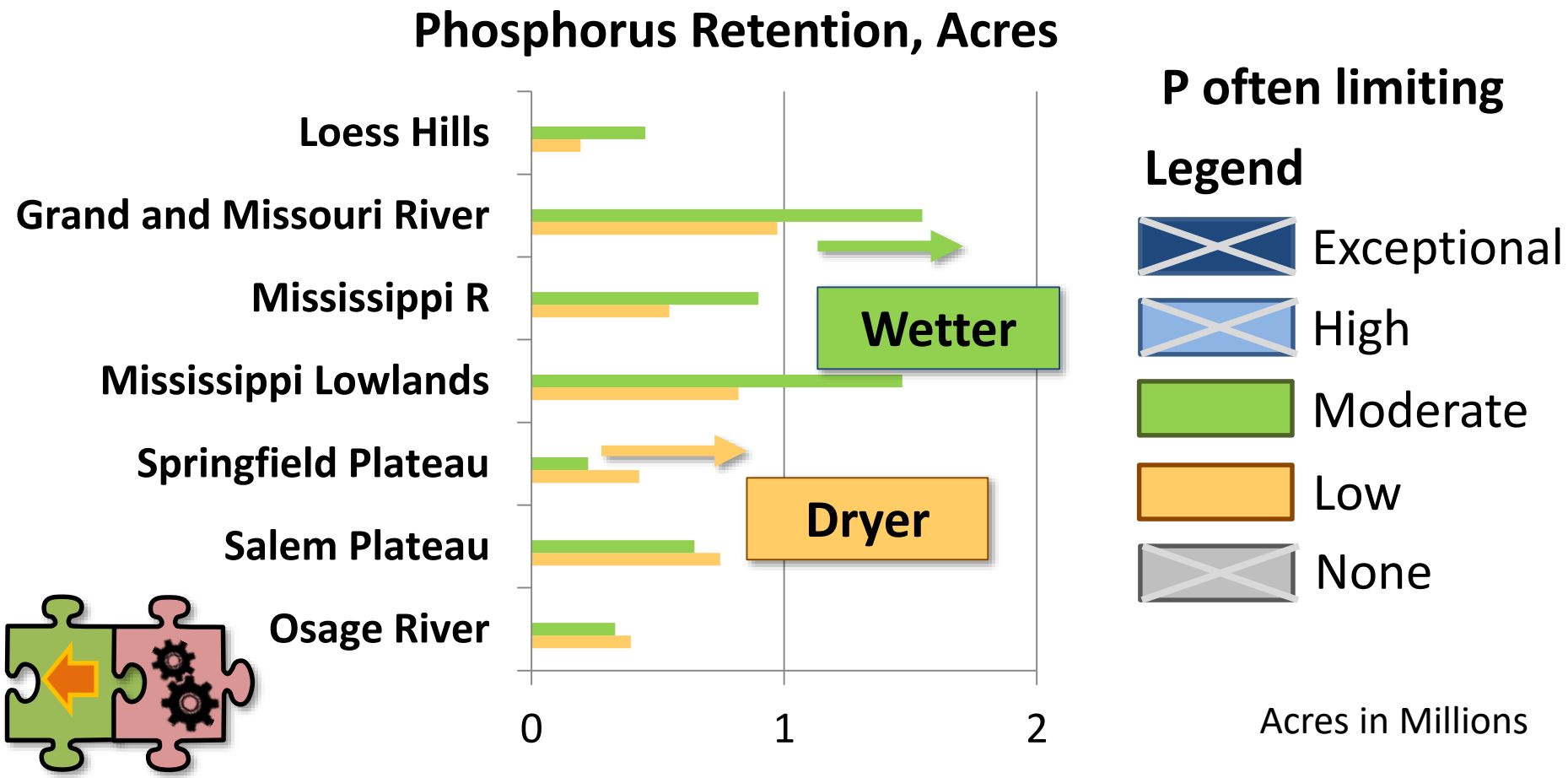



Where Ozark Fens occur

# Missouri Bottomland Functions:

## *Phosphorus Retention*

## Preliminary Results for Historic Potential



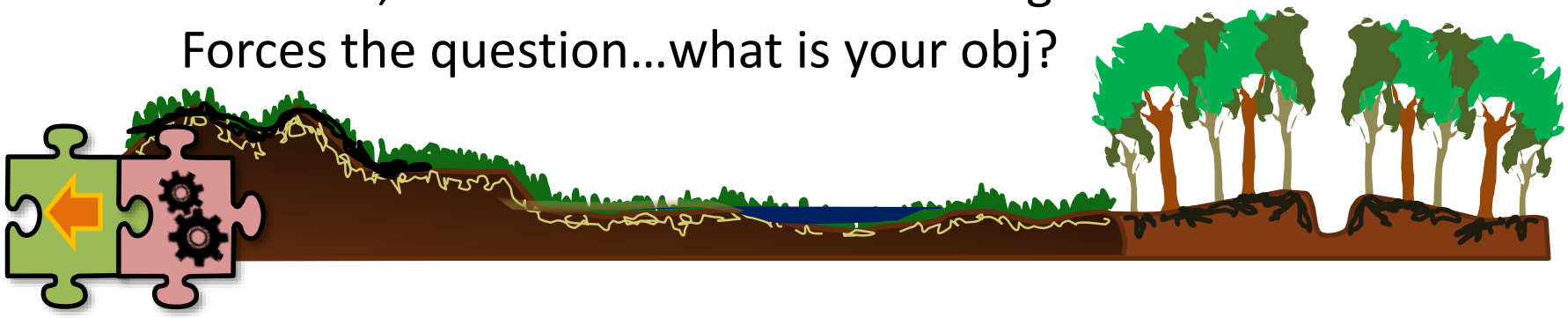
# Location, Location, Location

## *Historical Function Potential Varied*

| Ecological Functions | Ecological Site Description | | | | | |
|---|---|---|---|---|---|---|
| | Wet Upland Drainageway Prairie | Loamy Footslope Forest | Wet Terrace Prairie | Wet Floodplain Praire | Ponded Floodplain Prairie | Loamy Floodplain Forest |
| Flood Damage Reduction | None | None | Moderate | High | High | Exceptional |
| Phosphorus Retention | Low | Low | Low | Moderate | Low | Moderate |
| Nitrogen Reduction | Moderate | None | Moderate | High | High | Moderate |
| Streamflow Maintenance | Exceptional | High | Low | Low | Low | Moderate |
| Carbon Storage | Moderate | Moderate | Moderate | High | Exceptional | High |

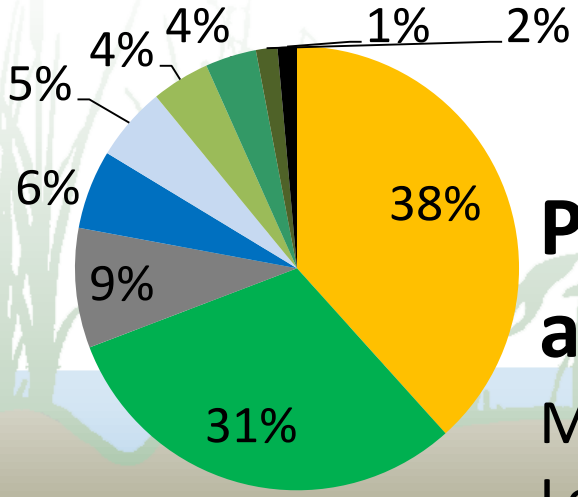
Good start, needs a little more tweaking

Forces the question…what is your obj?



# What about today's landscape?

- Geospatial Data
  - Cropland Data Layer
  - National Landcover Dataset
    - Provide regional summaries
    - Resolution can be an issue (30m)



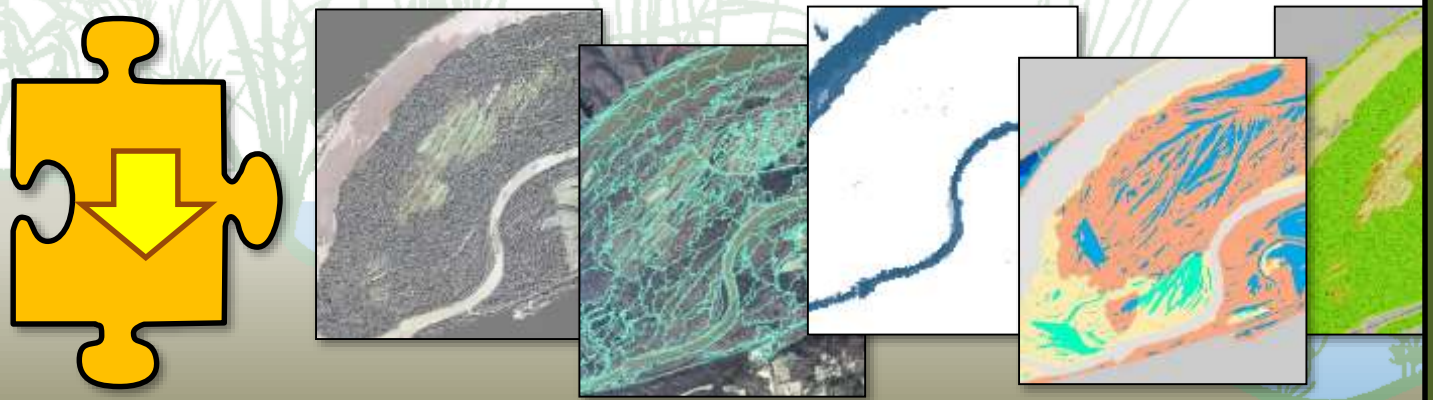

**Primarily Corn and Soybeans**

Missouri River Floodplain

Loess Hills Region

# What about today's landscape?

- Geospatial Data
  - Other options to refine spatial data and inform current bottomland extent
    - Enhanced NAIP: ERDAS Image Objects
    - Landsat: Water Inundation Frequency
    - Lidar: Topograpic Basins
    - Lidar Veg. Height: Woody Habitats



**In Progress**

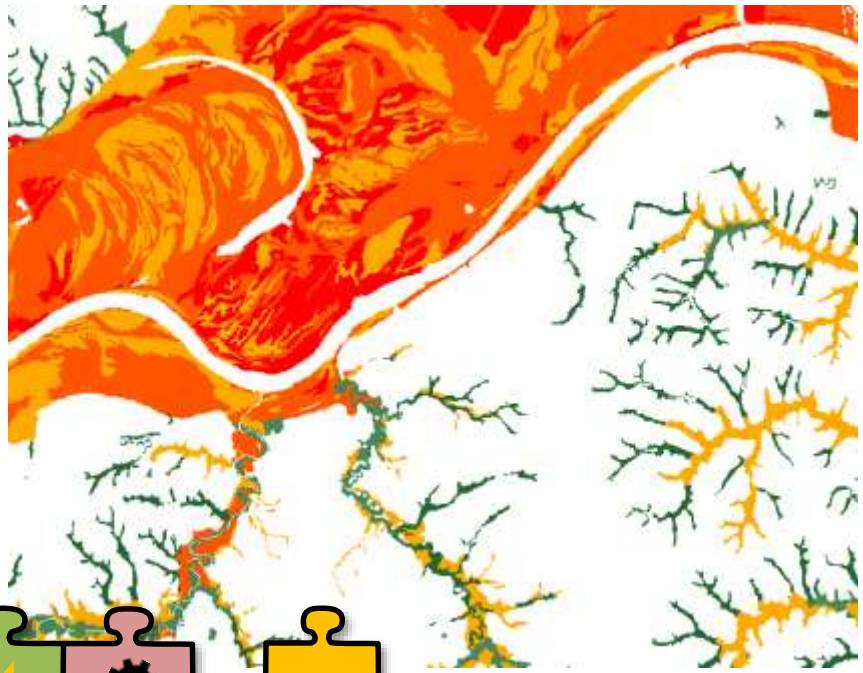
Better Resolution Current Extent

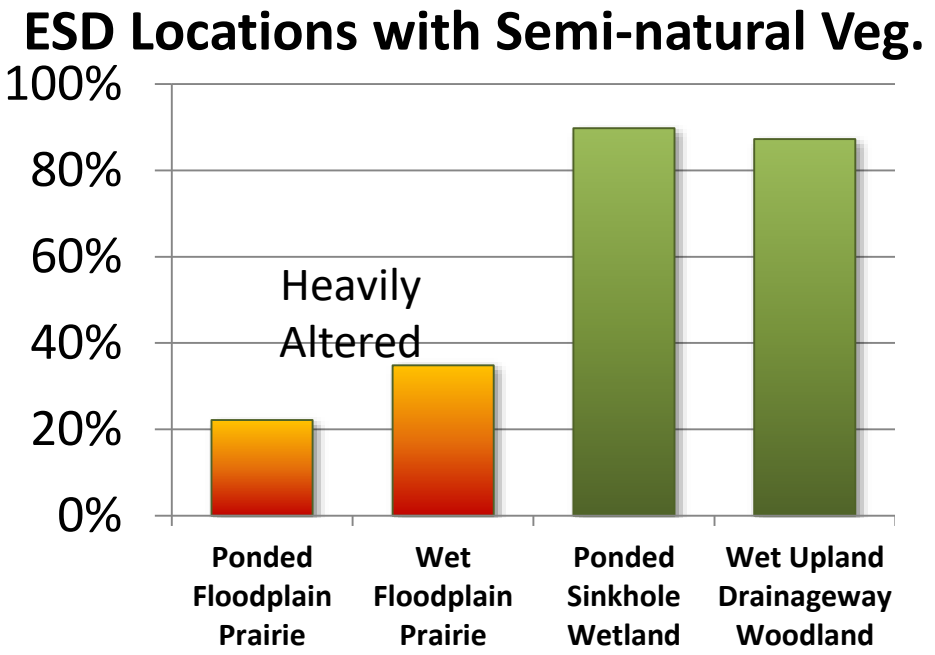
# Accounting For Changes

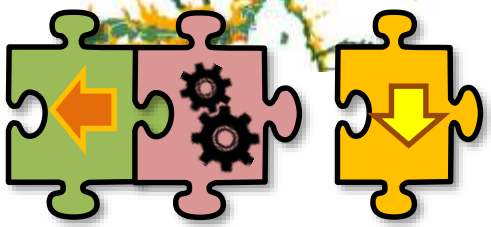
## Compare past (ESD's) and present(CDL)

*Preliminary Results*

- Check for Semi-natural vegetation (not crop/urban)





*Linking the past to current extent*

Still Intact

# Accounting For Changes

## Compare past (ESD's) and present(CDL)

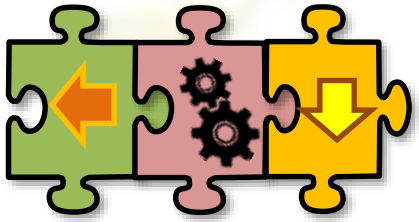
*Preliminary Results*

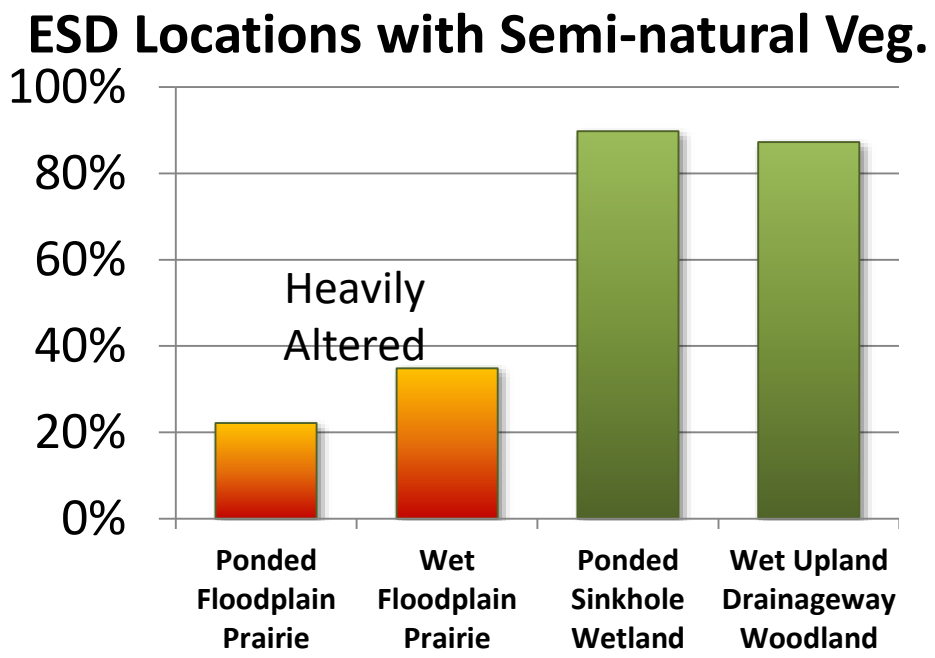
- Check for Semi-natural vegetation (not crop/urban)

*Doesn't count alteration in hydrology/fire

*Doesn't count exotic plant communities

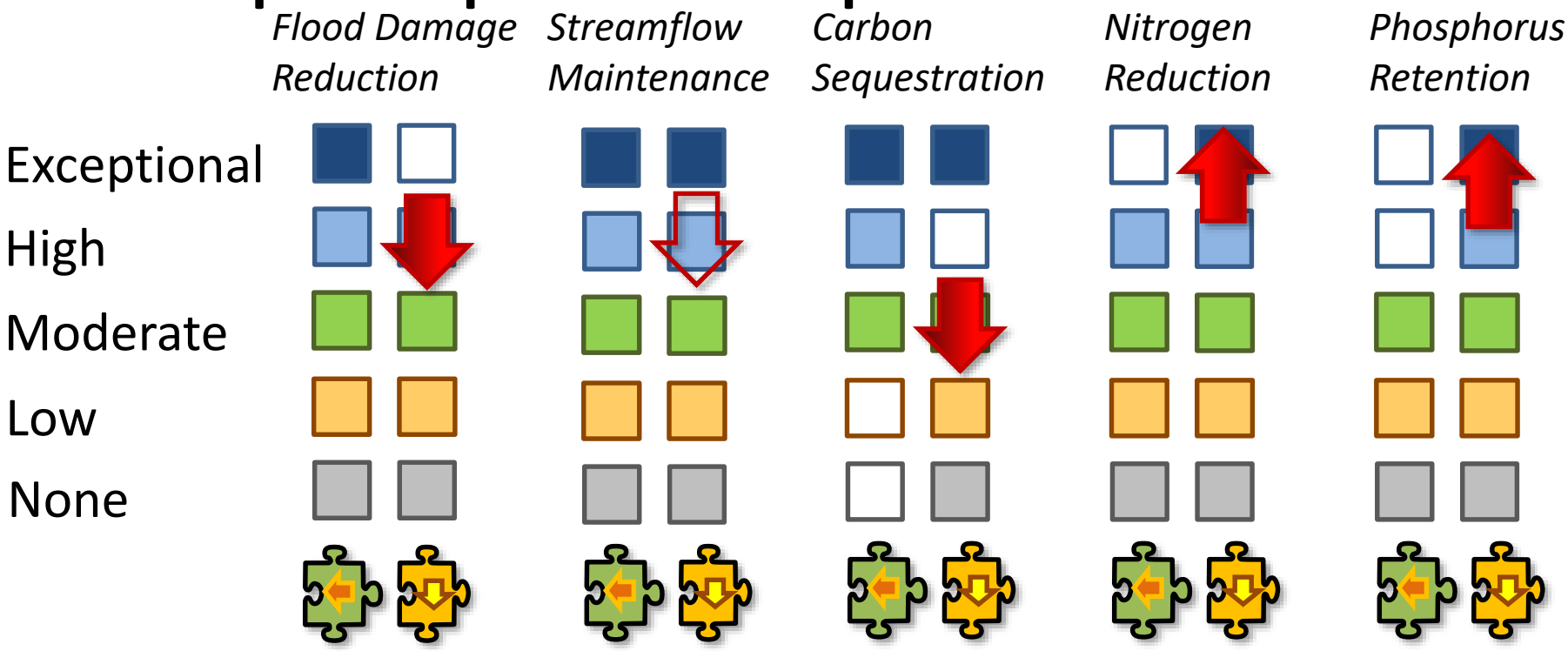
…..but it is a start

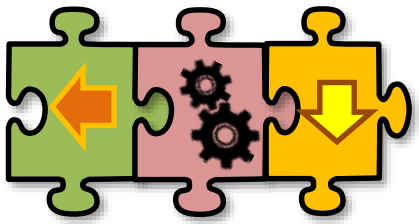




# Accounting For Changes

## Compare past and present functions



- Levees and channelization, wetland drainage
- Land use practices including clearing and tillage
- Addition of fertilizers and run-off

# Applying this Assessment

## Thinking about future goals and decisions

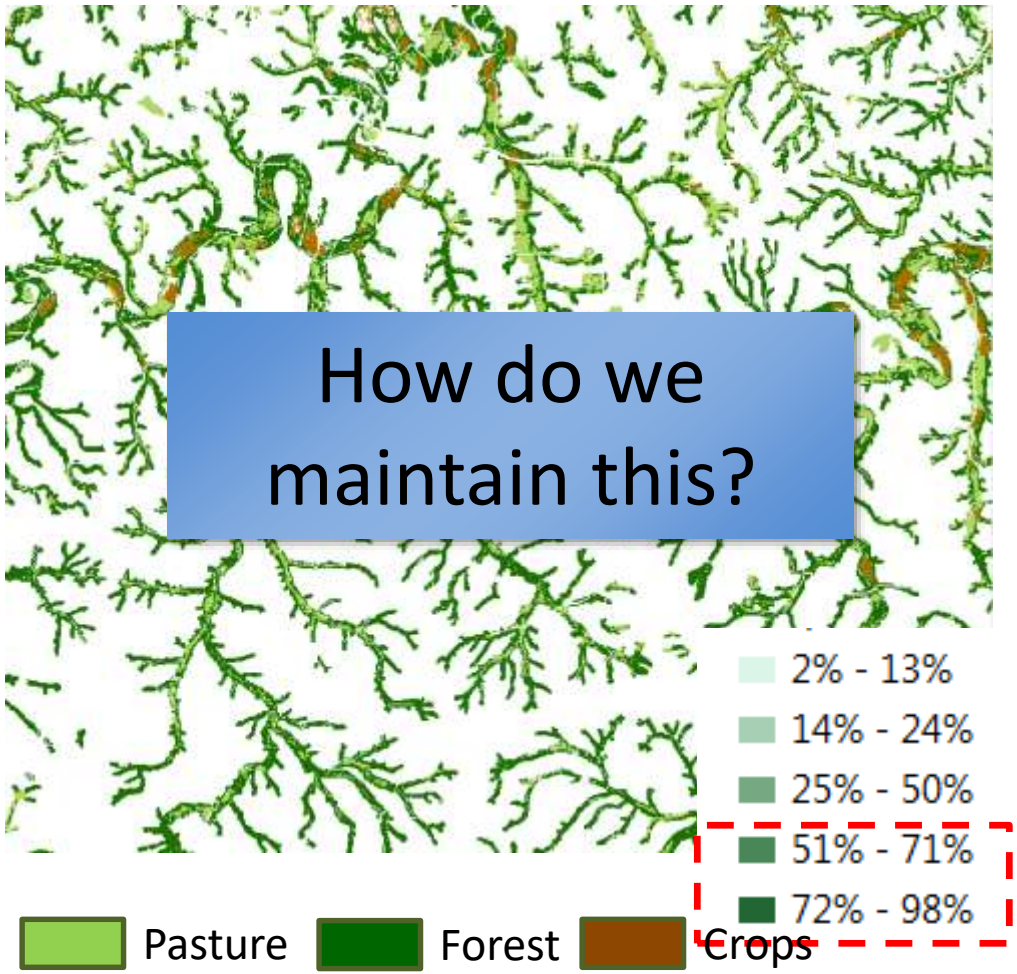
- Regionally Specific

Vegetation is Semi-Natural

Over half is forested or pasture

This is a good thing

**Salem Plateau**

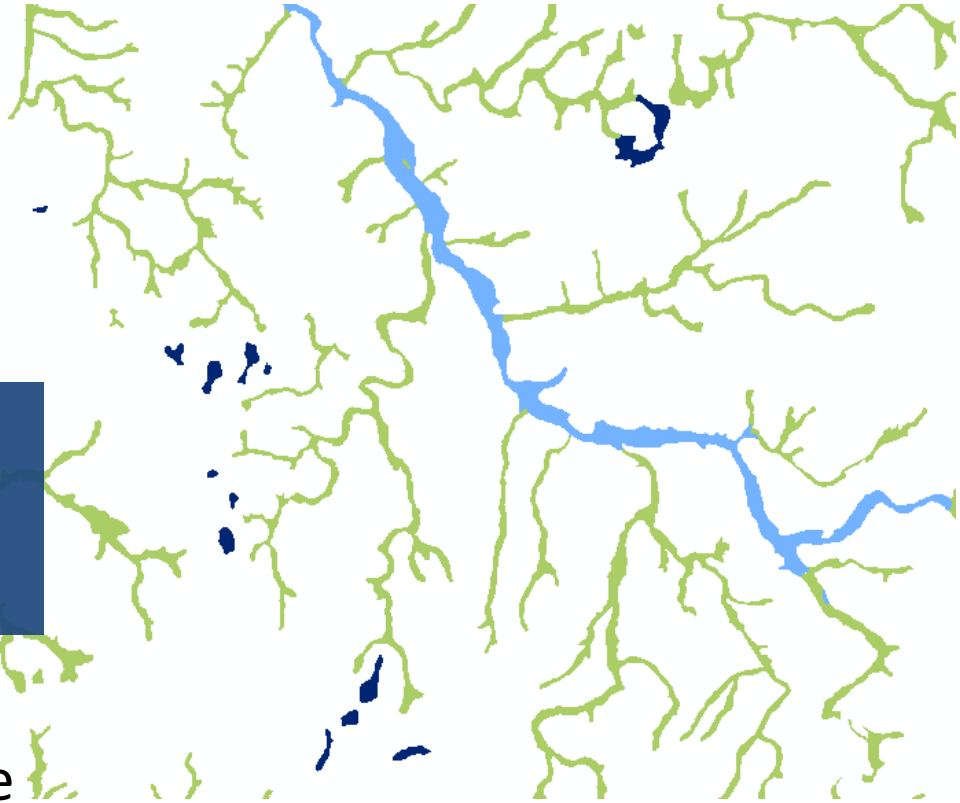


# Applying this Assessment

## Thinking about future goals and decisions

- Regionally Specific
- Local Partnerships

**Springfield Plateau**



Remaining fens and sinkholes often occur in clusters

Perhaps potential to create local awareness and partnerships among adjacent landowners

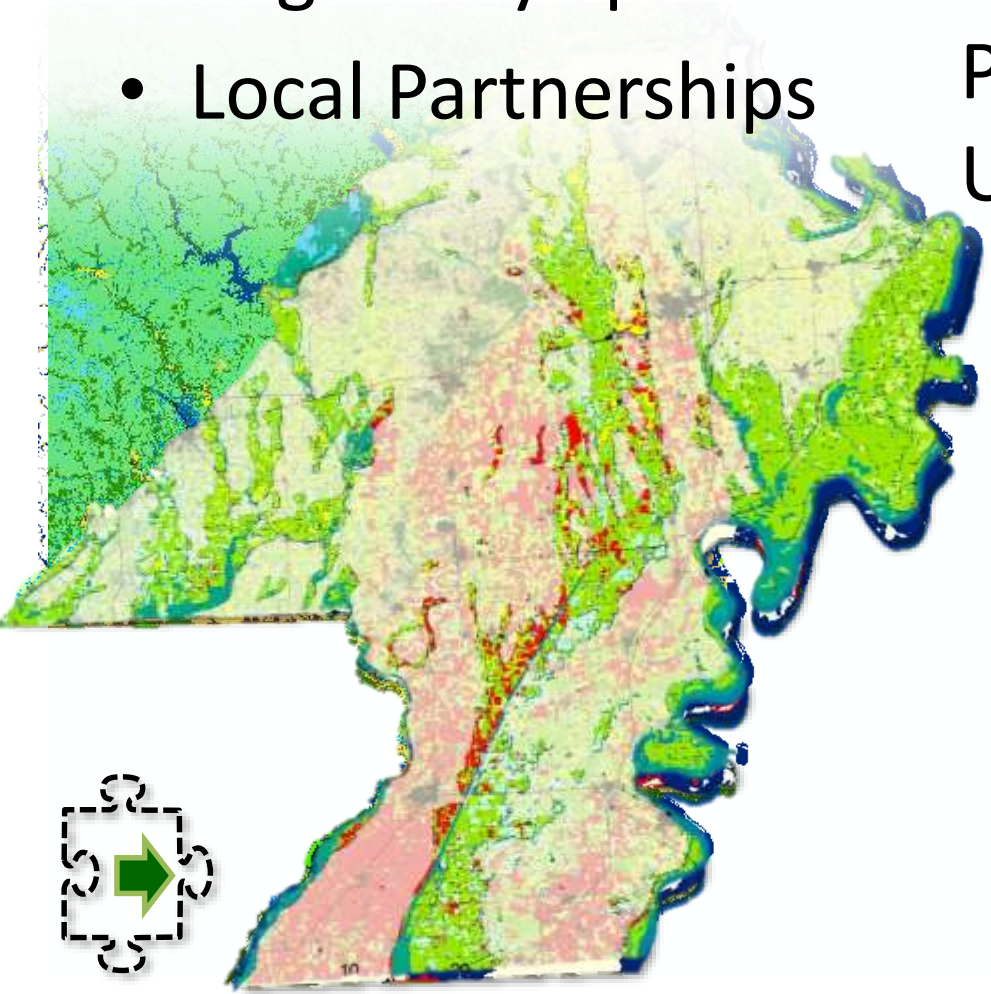
Options to protect…

…or even enhance

# Applying this Assessment

## Thinking about future goals and decisions

- Regionally Specific
- Local Partnerships



- Potential to Reframe Perceived Conflicts as Unrealized Opportunities

**Mississippi Lowlands**

Complete Land Transformation

Farmers are living with flooding

And still cropping

Perhaps there are means to compensate for multiple services of these locations

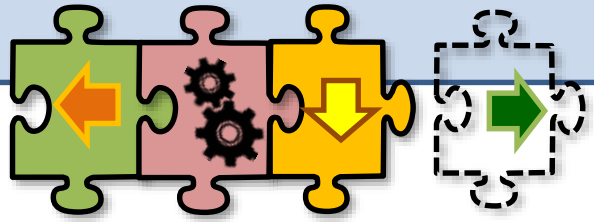
# Applying this Assessment

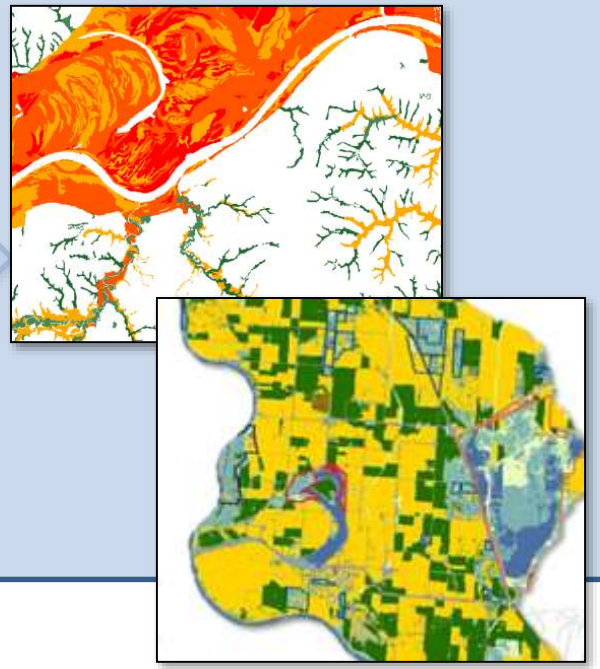
## Thinking about future goals and decisions

- Regionally Specific
- Local Partnerships
- Potential to Reframe Perceived Conflicts as Unrealized Opportunities

## A variety of options

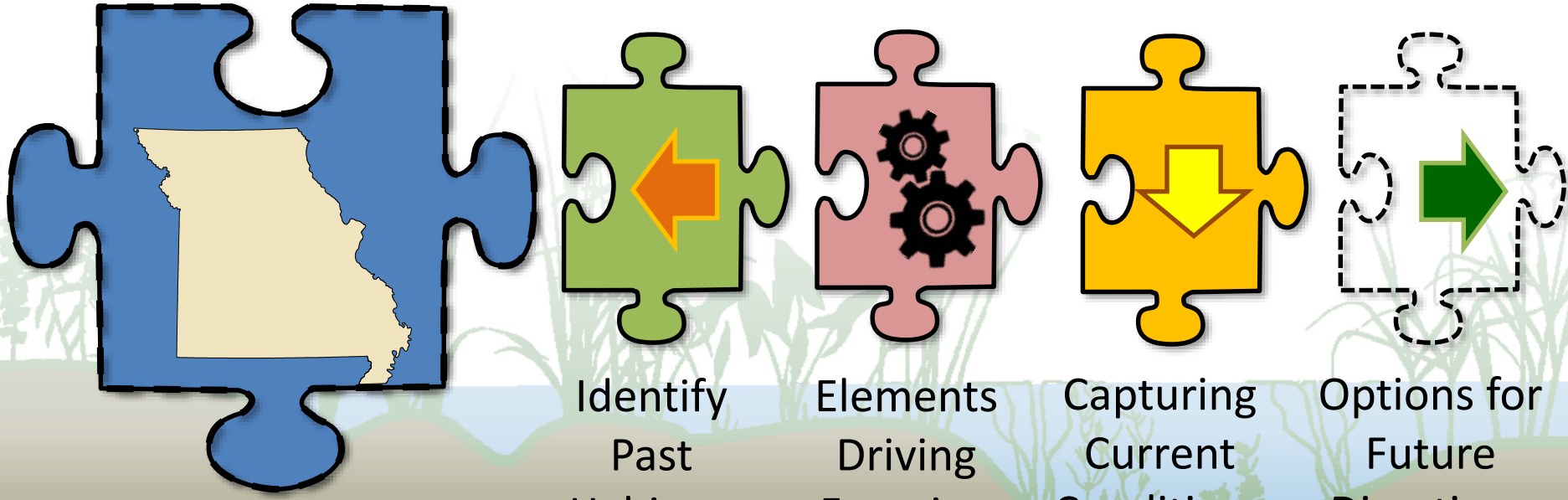
Assessment should help point out what is missing, what is working, and where improvement could be made





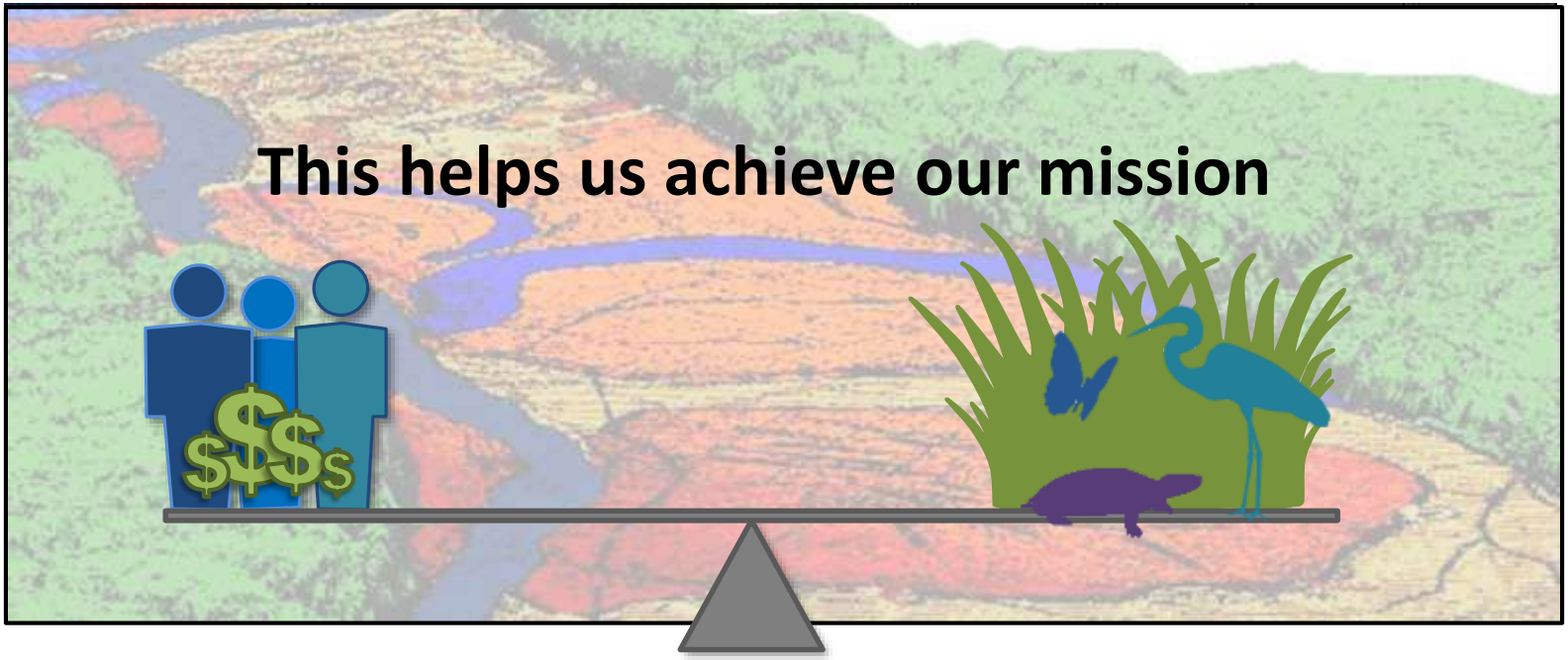
# Project currently in progress

- Funded by MDC and EPA
- Projected to finish by Sept. 2018
- Preliminary Results
  - Outlining Missouri's wetland landscape context



# By Gathering these pieces

- We can figure out they fit
- And have more complete picture of Missouri's bottomland
- Which can help us balance the needs



# Questions